THE HOUSEHOLD PHYSICIAN

BY J. McGREGOR ROBERTSON

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THE

HOUSEHOLD PHYSICIAN:

A FAMILY GUIDE
TO THE PRESERVATION OF HEALTH
AND TO THE DOMESTIC TREATMENT OF AILMENTS AND DISEASE,
WITH CHAPTERS ON FOOD AND DRUGS,
AND FIRST AID IN ACCIDENTS AND INJURIES.

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DIVISION II.

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PART I. THE HUMAN BODY: IN HEALTH AND DISEASE (*Continued*).

HEALTHY WOMANHOOD AND THE DISEASES OF WOMEN.

PART II. HYGIENE.

FOODS.

to which the term "hoop" is given, accompanying inspiration, due to the air rushing past the still narrow opening. Such spasms of the larynx are features in hooping-cough, so called because the hoop is specially characteristic of the disease, and in other disorders. Sometimes spasm of the larynx is due to irritation of one of the laryngeal nerves, caused by the growth of a tumour pressing on the nerve: it also occurs in hysteria. **Child-crowing** (*laryngismus stridulus*) is a spasm of the larynx. It is discussed under DISEASES OF CHILDREN.

The **treatment** depends on the cause. If irritating vapour has set up a spasmodic condition, breathing of steam is useful as well as hot applications to the throat. In many cases inhaling the vapour of ether or chloroform acts like magic; but it must be superintended by some competent person. In hysterical and nervous cases dashing cold water over the chest causes the spasm to relax.

Asthma (Greek *asthma*, panting) is an affection due to a spasm of the bronchial tubes, causing great difficulty of breathing. The bronchial tubes have a middle coat of muscular fibres (p. 251). If they contract they will diminish the extent of passage in the tube. In the walls of the smallest bronchial tubes there are no plates of gristle to keep the tubes open; thus contraction of the muscular fibres will readily narrow them, and, if it be excessive, close them altogether, so that air can no longer pass along the affected tubes till the spasm is relaxed. The amount of contraction is regulated by the nervous system, so that some irritable condition of the nerves supplying the bronchial tubes may occasion tonic contraction of the bronchial tubes, an attack of asthma.

Causes.—True asthma is thus a nervous disease; but the nervous irritation giving rise to an attack may be produced by many causes. It is a disease not unfrequently handed down from parent to child, showing itself perhaps in infancy, and most commonly at least before the tenth year. But it may begin at any period of life. The immediate cause of an attack may be the inhalation of irritating vapour or dust. It is a peculiar disease in this respect that the circumstances exciting an attack vary with each individual who is subject to it. Thus the smell of new-mown hay brings on a spasm in one, in others, the smell of some particular flower, or some particular animal, cat, dog, hare, rabbit, &c., or of some particular drug, for example, ipecacuanha powder. Some asthmatics suffer in one kind of atmosphere, others in an atmosphere of a totally different kind. Each person has to determine for himself what is not hurtful to him. Some asthmatics can live in one place for only one period of the year, and must remove elsewhere for other periods. Again, indigestion, a loaded condition of the bowels, states of the heart, liver, and kidneys, may all occasion asthmatic attacks.

Symptoms.—An attack may come on suddenly, or may be preceded by drowsiness and a sense of tightness and constriction in the chest. A peculiar itching of the chin, not relieved by scratching, is in some cases a forerunner of the attack. It commonly comes on at a particular hour, and generally in the middle of the night. The chief symptom is intense difficulty of breathing, which compels the patient to rise from his bed and place himself in the position that will enable him to expand his chest to the utmost for the entrance of air. He throws off clothing, and raises his shoulders; if there is anything above him convenient for the purpose he grasps it with his hands, thus fixing his shoulders in an elevated position and enabling his muscles to act from a fixed point in expanding the chest. Every attitude indicates a struggle for breath. His face expresses great anxiety; his eyes are prominent, his skin pale or bluish, and perspiration breaks out over his body. The breathing is attended with great wheezing.

The spasm may last for only a few minutes or for several hours. It may be present in a mild form for some time. When it passes off cough comes on, and with the cough a small amount of mucus is frequently discharged, but not in sufficient quantity to account for the difficulty of breathing. It usually recurs at more or less regular intervals or seasons. An asthmatic individual may live to a good age. The disease sometimes disappears in adult life when it has appeared in infancy, but it is usually lifelong. Repeated attacks are apt to occasion changes in the lungs, and changes connected with the heart.

Treatment.—In many cases a good dose of opening medicine, or an injection to unload the bowels, given at the very beginning, wonderfully relieves. Many remedies are used during the attack to relieve the spasm. Smoking ordinary tobacco, or better, stramonium (thorn-apple) sometimes does so. The stramonium is put in a pipe along with tobacco or alone, and a few whiffs taken. Inhalation of chloroform is beneficial, but its administration *must not* be attempted by the patient without some competent

person at hand. Nitrate of amyl has recently been largely used with some success. Five drops are placed on a handkerchief, which is held over nose and mouth, and inhaled till the person feels giddiness in the head, and the face is flushed and the eyes red. It ought not to be used by full-blooded persons, and indeed by no one without competent advice, for it may produce unconsciousness from the rush of blood to the head. A patent medicine—Himrod's cure—has proved very useful in many cases. It is a powder, and is burnt, the person inhaling some of the fumes. In the same way an asthmatic person will often find relief from burning in his room paper which has been dipped in a solution of saltpetre and then dried.[1] Relief is sometimes also to be had by taking a mixture containing 10 grains iodide of potassium dissolved in a little water, with 10 drops sal volatile (aromatic spirits of ammonia), 10 drops spirits of ether, and 10 drops tincture of belladonna. This dose may be repeated every six hours. Further, 10 drops of tincture of belladonna, with water only, taken every two or three hours, are of great use in the attack. The dose should be reduced if any bad effects—excitement, &c.—arise. The asthmatic patient should do all he can to diminish his tendency to attacks by taking simple nourishing diet, by keeping the bowels regular, perhaps by an occasional dose of rhubarb to relieve the liver. During the intervals also 5 grains of iodide of potassium may be taken thrice daily in water, and may be persevered in if, after some time, it is found to benefit the patient. An asthmatic person should try to discover what sort of climate suits him.

Hay-Asthma (*Hay-fever*) is a kind of catarrh to which some persons, not many, are liable during the months of May, June, and July, and which is supposed to be excited by particles from new-mown hay and other flowering grasses entering the air-tubes and setting up inflammation. Attacks have even been induced in persons by dust from dried hay. Dust from powdered ipecacuanha also produces the affection in some.

The **symptoms** are watering, redness, and itching of the eyes, irritation of the nostrils, accompanied by violent sneezing and much discharge, and similar irritation of throat, with cough, difficulty of breathing, tightness of the chest, sometimes with copious spit, &c.

Treatment.—The best treatment is the avoidance of the exciting cause by the person going to the seaside or to a place barren of grass during the months when the disease prevails. The wearing of a respirator made of a double fold of cambric to intercept the irritating particles is suggested. Many persons have found relief by taking 3–5 drops of the liquor arsenicalis of the British Pharmacopœia after each meal. Inhaling steam, tobacco, or stramonium smoke has also been useful.

Tumours, Foreign Bodies, &c.

Tumours occur in the larynx and other portions of the air-passages. A not uncommon form is that of warty growths in the neighbourhood of the vocal cords.

The **symptoms** are hoarseness and loss of voice, croupy cough, difficulty of breathing, and sometimes spasmodic attacks of obstructed breathing

The **treatment** is removal of the tumour by a surgeon. In some cases where suffocation is threatened opening of the windpipe is necessary to save life.

Foreign bodies of various kinds are common in larynx, windpipe, and bronchial tubes. It may be something one is eating passes suddenly backwards into the air-passages while the person is talking or laughing; or it may be a coin, pebble, button, or some such thing, one has been holding in the mouth, &c.

The **symptoms** and appropriate **treatment** are considered in the chapter on ACCIDENTS AND EMERGENCIES under the heading CHOKING.

DISEASES OF THE LUNGS.

Inflammation, Congestion, &c.

Inflammation of the Lungs (*Pneumonia*). This form of inflammation of the respiratory organs attacks specially the air-cells of the lungs, the lung substance itself. A description of the regular form will enable one to understand the nature of the disease.

The blood-vessels of the affected part of the lung are engorged with blood, specially the blood-vessels in the walls of the air-cells (p. 252), and also the vessels in the walls of the passages and fine bronchial tubes communicating with them. The pressure of blood in the vessels causes fluid (serum) to ooze from them and enter

[1] To prepare the paper, dissolve 4 ounces of nitre in half a pint of boiling water; soak thick red blotting-paper in it, then drain the paper and dry it. Burn, at one time, two or three pieces 4 inches square in the patient's room.

the cells and passages. As the inflammation continues, besides serum, other parts of the blood escape, namely, fibrin and also blood corpuscles (p. 214). This material completely expels the air from the affected portion of the lung, which thus becomes heavy and solid, and, being capable of clotting, the material forms a gelatinous mass in the air-cells. In the next stage of the disease this inflammatory material breaks down into matter, which is more liquid, and may be expelled from the air cavities and cells. As it is gradually expelled, coughed up, and spat out, the air spaces become unloaded, and air begins again to pass into them. If the case has pursued an entirely favourable course, the inflamed portion of lung will, after some time, be restored to its former activity and usefulness, with little trace of the serious changes it has passed through. There are thus three stages in the progress of the disease. The first stage is that of *congestion* or *engorgement*, the second is called that of *red hepatisation*, from Greek *hepar*, the liver, because the solidified part of the lung looks like a piece of liver, being red in colour owing to colouring matter of the blood; the third stage is that of *grey hepatisation*, the change in colour being due to breaking down of the contents of the air-cells.

Inflammation attacks the right lung twice as often as the left; and generally it is the lower parts of the lung that suffer, both lungs not often being inflamed at the same time. In the typical form a whole lobe is the seat of the inflammation, the lower lobe usually, but the upper lobes may also be affected. Hence the term **lobar pneumonia** has been used to distinguish from **lobular pneumonia**, which attacks the lungs in patches, separated by healthy lung tissue, and is more common among young children than among adults. The latter form is also called **catarrhal pneumonia**, since it is frequently a termination of catarrh or cold in the chest. It may also be stated that lobar pneumonia is also called **croupous**, because of the fibrinous material poured into the air-cells that characterizes the typical case. In most cases of pneumonia there is some amount of bronchitis (p. 270), owing to the affection of the smaller bronchial tubes. There may be also pleurisy (p. 266), that part of the pleura which is in contact with the inflamed portion of lung suffering with it. When the pleurisy is marked the doubled affection is called **pleuro-pneumonia**.

The pneumonia may not end, however, so favourably as has been supposed. A fatal termination may be due to the extent and violence of the attack, or to weakness, the heart being specially liable to fail because of the extra work thrown upon it in urging the blood through the obstructed lung. A chronic condition may be set up, which is considered later. In some cases, comparatively few, and only in those of very weakened constitutions, who suffer probably from other disease, the pneumonia ends in a part of the lung dying, and breaking down into fetid matter. This constitutes **gangrene of the lung**.

The chief **cause** of the disease is exposure to cold, and specially to sudden considerable variations of temperature, so that it is common in spring. It may, however, arise from extension of inflammation from the pleuræ or the bronchial tubes. Thus a common cold, neglected, may end in pneumonia. Other inflammations—those attending hooping-cough, measles, diphtheria, &c. —may occasion it, while it may arise in the course of other diseases, such as those of the heart, kidney, &c. Inhalation of irritating vapours or particles is another cause. For example, the solid particles inhaled by miners, knife-grinders, &c., are capable of producing it. Drinking a large quantity of cold water in an overheated condition of the body, by driving the blood from the organs of the belly to the lungs, may bring on an attack.

Symptoms.—The attack usually commences with fever, preceded in adults by severe shiverings, and sometimes in children by an attack of convulsions. The fever is sometimes very high, running to 104° and 106°. Within a short time, 24 hours or so, the nature of the disease is indicated by pain in the chest, rapid, shallow breathing, and cough, at first dry, but afterwards attended by a characteristic spit. The pulse is rapid, but not so much quickened as the breathing. The face is flushed, perhaps livid; the skin is dry and hot; the tongue is furred; appetite is lost; there is headache; and the urine is scanty and highly coloured. The patient should be made to spit into a dish. What is put up is at first rust-coloured, and so thick and gelatinous that it sticks to the dish and will not fall out though the vessel be turned upside down. This indicates that the disease is in what has been described as the second stage. In a few days the spit becomes more fluid and yellowish. Sometimes, however, there is little spit. Delirium is an occasional symptom, and is rather a serious one if marked. A common symptom is an eruption of watery blisters on the lips. The condition of the lung

can be readily ascertained by an examination such as described on p. 266. At the onset of the disease a fine crackling sound is heard, which soon disappears, the usual sound of air entering and leaving the air-cells being no longer heard, and a dull sound being produced by tapping the chest over the affected part, because that part is solid. When the matter begins to be expelled, the return of air is signified by the return of the crackling sound, and progress to recovery is indicated by the gradual restoration of the healthy sounds.

Recovery should begin about the fifth or seventh day by a disappearance of the fever. In about a fortnight the disease runs its course, though it may last only a few days or may be much prolonged.

Gangrene is indicated by the spit being fetid.

Treatment.—The person must be strictly confined to bed in a room kept moderately warm, but having a due supply of fresh air. A dose of castor-oil or seidlitz-powder should be given to open the bowels freely, and an ordinary motion should be obtained daily. Light but nourishing diet is to be administered, milk, beef-tea, &c., and water to quench thirst should not be denied. Occasional large poultices to the affected side, or flannel cloths sprinkled with turpentine, and covered with thick folds of warm flannel, will help to relieve the pain and difficulty of breathing. This is the kind of treatment, and in ordinary cases is sufficient with careful and attentive nursing. The acetate of ammonia mixture may be given (PRESCRIPTIONS—FEVER MIXTURES). In cases of exhaustion or weakening of the heart, stimulants are required, the carbonate of ammonia and senega mixture (STIMULANT MIXTURES), or wine, brandy, or whisky. These are not to be given without occasion. The disease, however, is so serious a one, and the details of treatment depend so much upon the individual affected, that no delay should be permitted in summoning a physician.

During recovery nourishing food, eggs, animal food, &c., are required, and quinine and iron tonic, cod-liver oil, &c., are advisable. For some time after the attack the person ought to exercise great care, since the lung cannot be supposed to recover its ordinary condition for a very considerable time after all signs of disease have disappeared.

Chronic Pneumonia (*Fibroid Phthisis* (consumption)—*Cirrhosis*) consists in a growth of fibrous tissue round the bronchial tubes and air-cells, gradually encroaching on them till the lung tissue is converted into dense, hard material. This newly-formed material in time shrinks, and in this way still further destroys the lung substance. It may also in parts break down, and cavities are thus formed.

Its causes are occasionally preceding acute pneumonia, bronchitis, &c. Inhalation of solid particles, such as miners, mill-stone grinders, colliers, flax-dressers, knife-grinders, stone-cutters, are exposed to, may also produce it. It is thus known as knife-grinder's consumption, stone-cutter's consumption, &c.

The **symptoms** are chiefly gradually increasing weakness, loss of flesh, more or less difficulty of breathing, and cough, with or without spit, which is often considerable, however. Sometimes spitting of blood occurs, and dropsy arises from the weakened condition of the heart which the disease produces.

The disease may be prolonged for many years.

Treatment consists in good food, fresh air, removal to a warm and equable climate, and tonics, such as quinine and iron, cod-liver oil, &c.

Congestion of the Lungs is a term in very common use, being often employed where in reality inflammation of bronchial tubes or air-cells is present. Of course congestion is always present in inflammation, the vessels being engorged or congested with blood before the proper features of inflammation have developed. Doubtless in some cases the state of congestion passes off without actual inflammation being developed. But a state of congestion independent of actual inflammation does occur, specially in diseases of the heart and during the progress of fevers. Thus where there is valve disease (p. 239) of the left side of the heart, in particular mitral valve disease, the blood does not pass onwards into the arteries with due rapidity, and becomes blocked in the auricles. The overfull condition passes backwards along the pulmonary veins (p. 223) till the lungs are reached, and there the vessels in turn become overfull, so that the pulmonary blood-vessels are engorged. Fluid escapes from them and pervades the lung tissue, which becomes dark, empty of air, and dropsical. This is apt to lead to active inflammation or to gangrene (death) of parts of the lung. Blood-vessels may burst and bleeding occur, the blood being partly expelled by the mouth, and partly poured out among the lung tissue, forming **pulmonary apoplexy**. Such congestion is not active but *passive*, the blood simply collects because it cannot pass onwards. In fevers, espe-

cially exhausting fevers like typhoid, the heart shares in the general weakness, and may become unable to propel the blood with sufficient vigour, so that congestion arises through enfeebled circulation. Old persons, or persons of weak condition of body, if kept lying in bed on the back for any length of time, as for example with a broken leg, &c., are liable to congestion, simply because the weight of the lung itself, with the person in the recumbent position, prevents due circulation. Such persons ought to be propped up occasionally to avoid this.

The **symptoms** are difficulty of breathing, perhaps bluish appearance of skin, and cough, with blood-stained watery spit.

Treatment.—The condition is a serious one, and calls for immediate attention and careful treatment, for one cannot tell how extensive the congestion may become in a short time. Treatment may require to be directed to the heart to strengthen it. Stimulants may be necessary. There can be no harm in the use of warm applications to the chest, specially low down on the back. But skill and knowledge are requisite to determine in each case the cause of the condition and its appropriate treatment.

Consumption and Spitting of Blood.

Consumption (*Phthisis*, from Greek *phthino*, to waste away—*Tubercle*—*Decline*).—This is a disease for which the name consumption, or a wasting away, is a very appropriate term. It is characterized by a breaking down of the lung substance into matter. Portions of lung become thus converted into collections of more or less liquid material; and if this matter passes into the air-tubes and is expelled from the lung in the form of spit, cavities remain.

There has been and is yet, however, great difference of opinion as to the real nature and cause of the disease. The general account given here is in accordance with the views of very eminent authorities, and explains what is continually being met with in experience.

Suppose a person is seized with inflammation of the lung. The changes, described on p. 274, go on in the affected lung, material is poured out of the blood-vessels and fills up the air-cells, so that the spongy character of the lung is lost, and it becomes solid, more like a piece of liver. If the case goes on well the deposited material is gradually removed from the air-cells, being partly picked up by lymphatic vessels (p. 200) and partly being passed up the air-passages and expelled in the spit. Air returns gradually to the cells and the work of the lung is resumed. Now it may be that for some reason or other the foreign material poured into the air-cells is not thus removed. Some circumstance, or circumstances, we need not now consider of what sort, prevents this favourable issue, and the matter is allowed to block up the lung tissue. But it is of low vitality, and by and by, after a longer or shorter interval, it tends to be converted into a sort of curdy or cheesy substance. Not only is it itself of low vitality, but its mere presence in the air-cells and the pressure it exerts upon their walls seriously diminish the vitality of the lung texture, which tends to become involved in the degenerative process. There may, therefore, be a part of the lung in which not only the inflammatory contents of the air-cells have become converted into cheesy substance but the tissue of the air-cells itself, so that the affected part of the lung becomes for ever useless. In course of time, moreover, the cheesy mass may become liquid, pass in portions into the bronchial tubes, and be spat up until the whole of the broken-down piece of lung has been expelled, a cavity being thus formed in the substance of the lung. This may occur in different parts of the lung, so that cavities are scattered through it here and there. Sometimes two cavities may exist near one another and finally open into one another, so that they form one irregularly shaped cavity. Sometimes, with the expulsion of the dead matters and the formation of the cavity, further breaking down may cease, the process not extending. In such a case the lung substance round the cavity gradually contracts upon it, diminishing its extent till it has been obliterated and only a scar is left in the lung to mark where it had been. This would be a case of natural recovery. It is, however, common for the wasting process to go on in the walls of the cavity, which gradually break down, so that the space becomes more and more extended, until even almost the whole of one lung may be converted into a single large sac. Into the cavities bronchial tubes open.

In a similar way to that just described may catarrh, such as that beginning in a common cold or in an attack of bronchitis, lead up to the development of consumption. Very specially to that form of inflammation of the lungs called catarrhal pneumonia (p. 275) are numerous cases of decline attributed. The air-cells become inflamed and filled with the products of the catarrhal condition, which undergo degeneration

and carry the texture of the lung with them in their decay.

Cases of consumption are very frequently met with in which the earliest occurrence seems to be bleeding from the lungs. Consumption produced by such an accident has been explained by supposing that the blood from the ruptured vessel has poured down bronchial tubes and filled up the air-cells in which they ended. In time the clotted blood has undergone the process of becoming liquefied, in which the air-cells have partaken, being unable to resist the evil effects of the continued presence and pressure of the blood.

Thus, put briefly and generally, the changes occurring in the lung in consumption are—the lung or part of it affected becomes solid by its air-cells, and bronchial tubes also, to some extent, becoming occupied by products of inflammation or foreign material of one kind or another. These become transformed into dead cheesy substances, and finally break down into liquid matters, the lung tissue being involved in the decaying process.

It is important to notice also that the cause of the irritation which starts the diseased process in the lungs may be fine solid particles drawn in with the breath, such as knife-grinders, miners, millstone-grinders, &c., are exposed to.

Another cause of consumption remains to be considered, which, according to some, is the only real cause of all cases, and that is tubercle. The relation of tubercle to consumption of the bowels is briefly noticed on pages 165 and 166, and there also the nature of tubercle has been described. Tubercles consist of small greyish nodules about the size of a mustard or millet seed. They are formed of cells, are of low vitality, and tend to break down. Softening begins in the centre of the nodule, and spreads till the nodule is converted into a yellowish mass of a cheesy character. The process spreads, and so the broken-down mass becomes gradually larger; the tissue, in which the nodules are situated, being involved, is destroyed in the course of the disease; neighbouring tubercles by their spreading meet, and so a large mass of the tissue may be hopelessly broken down. But the process may be arrested by the cheesy mass undergoing a chalky change and a sort of wall being formed which bars its advance. Now the lungs are a favourite seat of tubercle and specially liable to attack if the disease is present in any other part of the body. As a result of the deposit of tubercle in the lungs, as well as on account of the inflammatory changes that accompany it, the spongy character of the portion of lung attacked is lost and it becomes more or less solid or *consolidated.* The air-cells are filled and the tissue surrounding them invaded by a grey smooth gelatinous-looking material—the tuberculous matter. As this begins to soften it becomes yellow and opaque. Usually it becomes liquid, the substance of the lung involved with it sharing its fate, so that an abscess is formed in the lung. If this finds its way to a bronchial tube it is spat up and a cavity will mark the place which it previously occupied. If the process continue the cavity enlarges, as already described, or the cavity may be surrounded by a sort of capsule formed of condensed lung tissue, which shrinks, causing the cavity to contract. In short, the progress of tubercular consumption is the same as that described as due to inflammation of the lung, the only difference being in the alleged cause.

Of recent years Dr. Koch of Berlin has declared the cause of tubercle to be a minute rod-like organism, called the **tubercle bacillus,** which he has succeeded in growing in nourishing solutions in flasks, and which, injected into animals, produced an attack of tubercle. He has detected the bacillus in the spit of consumptive patients. It is not destroyed by drying, so that the spit of a patient suffering from tubercle may by drying be scattered as dust through the air, may be inhaled by a person whose habit of body makes him an easy prey to the disease, may take root in his lungs or air-passages, proceed to grow there, and develop the full-blown disease. If, then, these views are correct, the popular notion that a consumptive person may infect a healthy person with whom he resides, or with whom he sleeps, appears to be supported by facts. It may, thus, be that all cases of tubercular consumption—and according to some all cases of consumption are tubercular—are due to the action of an organism, the bacillus, which has gained entrance to the body. It should be stated, however, that various experimenters have apparently succeeded in producing tubercle in animals by injecting into their bodies matter and putrid material of various kinds, and by other means. That tubercle is one cause of consumption is certain, that tubercle can be produced by a special organism Koch seems to have proved, but whether it may be produced by other causes is not yet certain.

Particular parts of the lung are more apt to be attacked by tubercle than others. The upper parts of the lung, the apices. and specially the

apex of the *left* lung, are the favourite places where the destructive process begins, from which it tends to travel downwards.

Predisposing Causes of Consumption.—A seed may be sown in the ground, but it does not necessarily take root, grow, and flourish. Supposing a special germ to be the cause of consumption, a person may be exposed to it, but his body may not be a fit place for its growth. He may resist it successfully, in short. Just as two men may walk together into a fever patient's room, may be exposed to the same degree, and leave together, and while one "catches" the fever the other escapes. Still more, if consumption be not always caused by a germ, but is often the result of various unhealthy conditions operating on a particular constitution, still more will one man escape while another falls a victim. The various conditions, or predisposing causes, which favour the occurrence of consumption, will now be noted.

Age.—While the disease may occur at any age, fully one half of the fatal cases are between the ages of 20 and 40. It is less frequent in childhood and in old age.

Occupation.—Persons like knife-grinders, miners, stone-masons, &c., exposed to irritating dust-particles, are frequent victims. The occupation may lead to exposure, to confined habits of living, to loss of exercise, &c., and so favour the occurrence of the disease. Occupations that compel the body to be kept in constrained positions, especially such as hamper the breathing, stooping constantly over a desk, for example, are injurious.

Habits and Mode of Living.—Intemperance and other irregularities of life, and excess of various kinds, by their general effect on the body, are predisposing causes. In a similar way defective nourishment arising from bad or insufficient feeding, or from faulty digestion of one kind or another, has a very powerful influence.

Surroundings.—Breathing an impure atmosphere, such as is common in the small and ill-ventilated homes of the poor, too common also in workrooms of tailors and seamstresses, is a very favourable condition for the development of consumption. A damp soil and a moist atmosphere are also favouring conditions. A variable climate and a cold locality are bad.

Hereditary Influence.—Above and beyond all other predisposing causes is an inherited tendency to the disease. A person may inherit from his parents a weak condition of body which will make him an easy prey to consumption and many other diseases, but he may also inherit a special tendency to consumption in particular. Thus one observer found 75 per cent of consumptive patients belonged to families who had previously been afflicted with the disease. The disease is transmitted more commonly through the mother than through the father, but where one parent only is affected the father transmits it more readily to the sons and the mother to the daughters. Nevertheless it must not be forgotten that an inherited tendency to consumption may disappear under favourable circumstances, and may be greatly aided in disappearing by appropriate means.

In short, a person may *be born with* a delicate constitution and with a strong tendency to the disease; an ordinarily healthy individual may *acquire* a weakened constitution owing to his occupation, surroundings, as a result of various diseases, or owing to the pressure of poverty, anxiety, overwork, &c.; and a person may *acquire* a weakened constitution by his habits, by excesses, undue and prolonged excitements, &c.

Forms of Consumption.—Consumption manifests itself in two forms, the *acute* form, that of **Galloping Consumption**, as it is called, and the *chronic* form. In the former the disease is rapid in its course, ending fatally usually within three months, and sometimes within a few weeks. Sometimes it passes into the chronic form. There have been cases, believed to be galloping consumption, in which a cure was effected. In the chronic cases a common course is for the disease to progress from bad to worse till the patients die of exhaustion in from six to twelve months. But often there are successive attacks followed by apparent recoveries during several years, the disease finally gaining the mastery. Other cases, again, last for years; some ultimately become practically cured. The very varying duration of the disease is shown by the following table, which gives the results of 314 cases:—

24	died	within	3 months.
69	,,	between	3 and 6 months.
69	,,	,,	6 ,, 9 ,,
32	,,	,,	9 ,, 12 ,,
43	,,	,,	1 year and 18 months.
30	,,	,,	18 months and 2 years.
12	,,	,,	2 and 3 years.
11	,,	,,	3 ,, 4 ,,
5	,,	,,	4 ,, 5 ,,
1	,,	,,	5 ,, 6 ,,
3	,,	,,	6 ,, 7 ,,
1	,,	,,	7 ,, 8 ,,
3	,,	,,	8 ,, 10 ,,
11	,,	,,	10 ,, 40 ,,

Symptoms of Galloping Consumption.—It occurs usually in a young person who is suddenly seized with high fever. The pulse is rapid. There is great weakness. The tongue is coated and soon becomes dry, brown in the centre and red at the edges. The lips also become parched and brown, and crusts (called **sordes**) form on them and on the teeth. Looseness of bowels occurs, and often delirium. In many cases it is difficult at first to distinguish between such cases and typhoid fever. Later, cough comes on, and some spit, which may be rusty. The nature of such a case is only revealed by careful and systematic examination of the chest by auscultation and percussion (see p. 266). By this means a skilful physician detects signs of a portion of the lungs becoming solid and then breaking down. The breathing becomes embarrassed more and more, till it is evidenced in the livid hue. The case runs a rapid course, ending in death often in a few weeks by the exhaustion of the patient. Such cases are recognized as due to tubercle. In other forms of the acute variety pain in the chest may be among the first signs, with cough, yellow spit, quick pulse, and fever, which varies in amount, and is accompanied by chills and night-sweats. The signs of destruction of lung-tissue are obtained on examination. Blood-spitting may be the first sign in an attack of acute consumption.

Symptoms of the Chronic forms of Consumption. — The symptoms of the chronic variety are very variable, especially in the early stage, and may develop slowly so as to attract little attention. Cough is usually among the first of them—cough which is at first dry and hacking, apt to be specially troublesome on lying down at night and rising in the morning, and later accompanied by spitting up of clear material—mucus. It is accompanied by weakness which gradually increases, and is attended with loss of flesh. For some time these may be the only symptoms. Gradually the spit becomes more or less yellowish, being mixed with matter (pus). The digestive organs are frequently disturbed. Careful examination in the early stage will often show that the temperature rises above the usual in the afternoon and is below it in the morning, and that the breathing is faster than usual and the pulse quickened. Examination of the lung may detect alterations in the breath sounds (p. 266), but these it is useless to specify here. Very commonly the patient does not complain of shortness of breath till great alterations have taken place in the lungs, so stealthily do they develop. In the later stages there are increase of cough and yellowish spit, and, as the disease becomes confirmed, feverish attacks are marked, becoming of the hectic character—that is, the fever is preceded by a chilly sensation and followed by copious sweats. The fever causes a brilliant spot on the cheeks—the hectic flush. A tendency to night sweats is not infrequent in the early stage, but in the later stages they form a very prominent and exhausting feature of the disease. Examination of the lungs in the later stages gives evidence of advanced breaking down of the lung-tissue and probably of the formation of cavities. The chief symptoms then are cough, spit, increasing exhaustion and loss of flesh, feverish attacks and night-sweats. The disease may begin by blood-spitting, which may come up with the spit, streaking it, or in quantities at a time; and loss of blood in this way frequently occurs during the progress of the disease, aggravating the condition by the weakness it induces. Moreover, consumption may slowly and insensibly arise from chronic bronchitis and other lung affections.

In the progress of the disease other symptoms indicate that various other organs are affected. Notably in advanced phthisis is looseness of the bowels common. In some cases it is most intractable, increasing the exhaustion of the patient with great rapidity, being due to deposit of tuberculous matter in the bowels; and it may be accompanied by pain in the belly.

Fistula in the anus (p. 194) is frequent in consumptive patients, and the healing of the fistula has, in many cases, been followed by rapid progress of the disease. On this account, though it is curable by a surgical operation, many, who fear consumption, prefer to leave it alone.

In some instances alterations of voice, hoarseness or loss of voice, are the first signs of the growing disease. Sometimes they are due to tubercular ulceration in the larynx. Whether this is the cause can be determined by an examination with the laryngoscope (p. 263).

Confirmed consumptive patients may be known by certain curious physical characters: clubbed form of the ends of the fingers and the nails, pearly-white colour of the white of the eye, wide condition of the pupil (the black of the eye), and the presence of a reddish or purplish line along the junction of the gums and teeth.

Death is due commonly to exhaustion, but may occur suddenly owing to great loss of blood

by the lungs, or may be caused by some complication. Dropsy, occurring usually in the feet and legs, and the presence of thrush in the mouth are signs of the approach of the end.

Treatment.—The general treatment of consumption is plainly indicated. Everything that can aid in maintaining and increasing the person's health must be rendered available. The meals should consist of a nourishing diet, of an easily digested kind, and should be at regular and stated intervals. The diet should be generous rather than restricted. The digestive powers are often weak, and the stomach and bowels disordered. They may be aided by the use of tonics, the iron, quinine, and strychnine tonic, or the acid tonic (see PRESCRIPTIONS), and the movement of the bowels should be as regular as possible. The functions of the skin ought to be attended to. For this purpose daily sponging with tepid water of the surface of the body, and especially of the chest and back, followed by brisk rubbing, is very valuable. Woollen underclothing should always be worn.

Regular gentle exercise should be engaged in, as much time being spent in the open air as the person's health will permit. Gentle gymnastic exercise of the sort to expand the chest is useful if carefully employed. The consumptive must be surrounded by healthy conditions, pure air being essential, as large, airy, and well-ventilated a house, as circumstances will permit, being selected for residence, kept at a regular temperature, and free from draughts. Special attention should be given that the sleeping apartment has a free circulation of pure air, but is also free from draughts. The house should be in a dry and sheltered situation, built on sand or gravel, and well drained. The person's own habits should be well regulated. Early hours should be indulged in, though a due amount of sleep ought always to be obtained; fatigue is to be avoided and excitement; excessive work, physical or mental, and worry, being very depressing, are very injurious. The sort of climate that suits the consumptive is that which is dry, mild, and not liable to sudden variations. In England Hastings, Ventnor in the Isle of Wight, and Torquay, are favourite places, the south of Spain, Madeira, and the Riviera, on the continent of Europe, and Egypt and South Africa. Sea voyages to Australia or New Zealand are of great value, and the Andes, Rocky Mountains, and Alps are much frequented by consumptives. Of course on a patient's health and ability to travel depends largely the choice of a climate. High altitudes are now much sought after, Davos among the Alps being a favourite place for English patients.

The main medicinal treatment of consumption consists in the administration of cod-liver oil. It is of course in the early stage that it is most useful, and then when given regularly for a long time its effects are often marvellously beneficial. Under its use the patient frequently gains flesh and strength, and cough and spit are diminished. It should be given in small doses at first, of one tea-spoonful or so, twice daily, till the person gets used to it, when it is gradually increased till three table-spoonfuls are taken daily. It seems to agree best when taken shortly after meals and before going to bed. To disguise its taste it may be given in milk, butter-milk, claret, or in any other way the patient likes. Exercise in the open air greatly aids its digestion. There are not very many people who, by various devices, cannot be gradually accustomed to its use. With a few, however, nothing can make it agree. For them cream, glycerine, or fat of meat—such as fat bacon—may be tried instead, or some of the various preparations of malt extract. Iron tonics and quinine are also administered with benefit in consumption.

As to special treatment for various circumstances it is doubtful whether it would be of much service to note it in a work like this. To direct treatment beyond what has been described would be too much responsibility for any but a medical attendant. For example, blisters are often valuable for relieving pain and for checking inflammation going on in the lungs. For the relief of constant and harassing cough the administration of opium in some form or another is always a necessity, and for the checking of exhausting night sweats belladonna is one of the most useful of drugs. But whether or not a blister should be applied, and where it should be applied, what form of opium should be given, and how much, what dose of belladonna and so forth, are questions to be answered in each case according to the circumstances. In the unavoidable absence of a medical attendant 5 to 15 drops of laudanum may be cautiously ventured on twice or thrice daily if really necessary. If the cough seems to be due to difficulty of getting up the spit, 20 to 30 drops of ipecacuanha wine with syrup of squills will help in its removal. To check sweating a pill of $\frac{1}{4}$ to 1 grain of belladonna is given at bed-time, and the patient's body should be sponged once or twice daily with vinegar and tepid water (twice as much water being used as of vinegar). The

checking of looseness of the bowels is often a most difficult thing to effect. One of the best preparations consists of from 5 to 10 grains of Dover's powder with 10 grains of bismuth added. Dilute sulphuric acid (10 to 15 drops in water) sometimes relieves. To control bleeding from the lungs 10-grain doses of gallic acid at intervals of three hours are useful. Liquid extract of spurred rye (*Secalis cornutum*) is most efficient for this purpose, of which from $\frac{1}{2}$ to 1 teaspoonful in water is given at a time, and repeated every two or three hours as long as necessary. The active principle of the drug, ergotine, may now be had in pill. Its dose is 3 to 5 grains, and it may be used instead of the liquid extract. A patient who has had copious bleeding from the lung should be kept quiet, lying in bed with head high in a cool room, and small pieces of ice may be given to suck.

The Prevention of Consumption.—It should not be forgotten that for those who are delicate and suspected of a consumptive tendency much may be done to ward off the disease. It ought never to be taken for granted that a person is bound to be a victim of consumption either because of the state of health of the individual or because of the family tendency. On the contrary many persons have been saved from such a fate by such attention and care as have been recommended in the early paragraphs on treatment, who otherwise would have had little chance of escape. Such measures as have been urged ought to be rigidly carried out. *Ordinary colds ought never to be neglected*, and if cough, &c., threaten to remain change of air should be tried without delay. Mothers who, because of family tendencies, fear for their children are apt, in their anxiety, to do the very things that are most hurtful. They smother them up with clothes, and so hamper them in this way that all their healthy movements are restricted, those of the respiratory organs among the number. They keep them confined to hot rooms, and restrict their out-of-door exercise, and when the children are allowed out they are cumbered with so many wraps that walking is a labour; the children become hot and covered with perspiration, and wish to sit down on every odd door-step or other equally cold resting-place. Such measures as these are the grossest possible mistake, for, instead of warding off the threatened danger, they directly invite it. Abundance of fresh air is an essential in the prevention of consumption, and regular systematic exercise of the body, particularly of the chest muscles, is another. The child who is confined to warm rooms or kitchen, and whose bodily temperature is artificially maintained instead of by its own activity, is unable to resist the influence of the slightest breeze. It is a hot-house plant that will be speedily blighted when brought into the open air. But it was made for the open air and not for the hot-house, and it is the ignorance or stupidity (let the proper terms be applied, though they are strong) of mother, nurse, or guardian, that has overturned the design of nature, and substituted sickliness and weakness for health and vigour. There is, however, the other extreme, equally at variance with sense and fact as the former, the extreme of which parents and guardians are guilty who adopt what is called "the hardening process." They expose their children to all sorts of weather improperly protected; they treat them to daily cold shower-baths as a matter of routine, and so on, in the expectation that they will become used to and unaffected by exposure. The only proper course is for children to be clothed so that no healthy movement is restricted, and so that a regular and moderate degree of warmth is maintained. Plenty of exercise in the open air should be allowed; but excessive exercise, that throws the child into perspiration and leads it to sit down to cool, is to be cautioned against. In warm weather the clothing should be lighter to counterbalance it, and in colder weather heavier, both extremes being avoided in which the child is either never warm unless romping or always so warm as never to be able to romp.

The preventive treatment for adults is such as has already been described under general treatment.

Spitting of Blood (*Hæmoptysis, Bleeding from the Lungs*) is to be carefully distinguished from vomiting of blood, in which case the blood comes from the stomach, is commonly dark from contact with the acid juice of the stomach, and is mixed with the contents of the stomach. In hæmoptysis the blood comes from the lungs or air-passages in them, and is expelled by coughing. It may be present in the spit merely as spots or streaks, or uniformly colour the spit, or it may come in clots, or in gushes of bright blood, frothy because mixed with air. Where it rushes out in quantity no effort at coughing may exist, or there may be but a slight cough. It must be observed that streaks of blood may be present in the spit and not come from the lungs at all, but from the back part of the nostrils or the pharynx, and may, consequently, mean little or nothing. Further, bleeding may take place

from the nostrils so far back that the blood finds its way into the back of the throat, and is expelled by a very slight effort. The true nature of such cases will be revealed by an examination of the back of the throat with a strong light, when a fine line of blood is likely to be observed down the back wall of the pharynx from above.

Bleeding from the lungs may be the result of many varied diseases, such as congestion, inflammation, or ulceration. It may be apparently the first occurrence in an attack of consumption. Persons may be repeatedly attacked with hæmorrhage from the lung and no special sign of lung disease be discovered. The bleeding may return at intervals, and consumptive disease not show itself for years. At the same time consumption may speedily follow the first attack. Bleeding is also a frequent occurrence in the progress of consumption, vessels being opened into by the destructive process. In pneumonia (p. 274) loss of blood from the congested vessels gives the rusty appearance to the spit, and in bronchitis streaks of blood in the spit are not uncommon. The bursting of an aneurism (p. 244) into the lungs, or one of the bronchial tubes, will occasion profuse bleeding, the patient dying speedily. Cancer also causes bleeding.

Where the loss of blood is considerable the nervous shock to the patient is usually great.

Treatment.—A person who has suddenly coughed up a considerable quantity of blood should be put to bed, the shoulders being raised. The room should be cool and perfectly quiet. Ice in small pieces given for sucking aids in checking the bleeding. The best medicines are dilute sulphuric acid (30 drops every three hours) in water, gallic acid 10 grains, every two or three hours as long as necessary, or ergotine 3 to 5 grains repeated as required, or ½ to 1 tea-spoonful of liquid extract of ergot instead.

Stimulants are not, as a rule, advisable, tending, as they do, to excite the heart, and so increase the bleeding. Food should be given *cold* for some time after the bleeding has ceased.

If the attack comes as a surprise to the patient, who has seemed a moderately healthy person, it should induce him or her to have a careful examination made of the lungs and heart specially, and its warning should not be disregarded.

Dilatation and Collapse of the Lungs.

Dilatation or Emphysema (from Greek *emphusao*, to dilate) is a condition of all or parts of the lungs in which the air-cells are larger than usual, being greatly distended. The walls of the air-cells have lost their elasticity, so that they cannot recover from undue stretching. The condition is the result of some excessive pressure exerted on the walls of the cells by the air within them. It is a common consequence of blocking up of parts of the lung. If the chest enlarges as usual the parts of the lungs that have become blocked up cannot receive any of the entering air, and the healthy parts must consequently stretch to make room for it. If the unusual state continues for any time, the permanent overstretching of the walls of the air-cells destroys their elasticity, so that, if they had the opportunity, they could not recover themselves. It is a consequence of bronchitis, of blocking up or destruction of parts of the lungs, and of other diseases. It may be originated by constant playing of wind-instruments, and by the efforts to raise heavy weights. Though a disease of adults, children affected with croup, hooping-cough, &c., are liable to it.

Its **symptoms** it is needless to discuss, the chief being shortness of breath. It develops a barrel-shaped chest.

Its **treatment** is mainly such as will tend to support and nourish the body, improve the general health and condition of the blood. Nourishing food, and attention to the bowels are thus of the utmost importance, and to these is added the administration of iron tonics and cod-liver oil.

Collapse of the Lungs (*Atelectasis*, Greek *atelēs*, imperfect, and *ektasis*, widening).—The air-cells are empty of air and their walls collapsed, so that the part of the lung affected is more or less shrunk and solid. This may be effected by pressure, for instance by the pressure of a great quantity of fluid in the pleura as in pleurisy (p. 266). It may be present in bronchitis and other diseases of the lungs owing to plugs of matter occupying bronchial tubes and acting like ball-valves, permitting air to leave the part of the lung which the tubes supply, but none to enter. Children during the first year of life, especially the weakly and ill nourished, are specially apt to suffer from this affection in the progress of measles, hooping-cough, or croup. Atelectasis is the term applied to the condition of the lungs of children who have not breathed after birth—the air has not entered to expand the air-cells.

The detection and treatment of the condition are the work of a physician.

Tumours.

Tumours of various kinds have been found in the lungs. **Cancers** and other malignant growths are not uncommon, leading to destruction of lung tissue, and sometimes eating into blood-vessels, causing death by bleeding.

Injury of the Lungs.

The lungs are sometimes implicated in wounds of the chest. A fractured rib, for example, may wound the lung and cause spitting of blood. In such cases bandaging the chest to prevent movement of the injured part, or the treatment by strips of plaster as recommended for broken ribs (p. 48) is desirable. Difficulty of breathing, spitting of florid and frothy blood, are among the symptoms that indicate the affection of the lungs. The patient should be kept quiet, propped up in a half-sitting position, and remedies noted under HÆMOPTYSIS (p. 282) should be used.

SPECIAL SYMPTOMS CONNECTED WITH AFFECTIONS OF THE LUNGS AND AIR-TUBES.

Cough is a symptom of many different affections, and its treatment depends on its cause. It consists of a deep breath followed by closure of the glottis, and a series of rapid expiratory efforts. It is the result of a nervous action originating in an irritation of the ends of sensory nerves distributed to the inner surface of the larynx. The impression is conveyed to the centre for breathing in the medulla (p. 93), and from thence messages pass to the muscles of respiration and to those of the glottis, by which the cough is produced. The irritation which begins the process may be owing merely to cold air entering the larynx and passing over an inflamed surface. It may be that the surface is not inflamed, but that the indrawn air contains irritating particles. Again it may be caused by the tickling of some phlegm poured out by an inflamed membrane, or of some matter swept up from the lungs. It may also be a mere nervous affection, or due to some condition of the blood, as in gout and rheumatism, or the nervous irritation may arise from disordered stomach or liver. The cough is thus either dry, that is, unaccompanied by spit, or moist when it is so accompanied. It varies in character. It is spasmodic in hooping-cough and croup. The "hoop" which attends the former readily distinguishes it, and the loud brassy sound of the latter is characteristic. In cough from obstruction of the air-passages arising, for example, from an inflamed and swollen lining membrane, such as common cold produces, it is also spasmodic and wheezy. Where the vocal cords are rough by the swelling it is harsh, barking, and hoarse, and when the cords are covered with membrane, as in diphtheria, it is wheezy and voiceless.

The treatment depends so entirely on the cause that it is impossible to give any special treatment for the mere symptom. It may be noted, however, that one of the commonest and most troublesome coughs attends slight cold from swelling and irritability about the larynx. Warm poultices over the front of the neck greatly soothe and relieve it. If that fail, a piece of flannel sprinkled with turpentine, or with soap and opium liniment, should be placed directly over the larynx on the neck. If a mustard poultice be used, and it is often very efficient, it should be placed lower down at the top of the breast-bone. A cough, due to this affection, is usually dry, and if obstinate, great pain is experienced in a line across the front of the chest, the line of the diaphragm (p. 253), occasioned by the severe and constant spasmodic movement of the chief muscle of breathing. Other drugs failing, a dose of 15 to 20 drops of laudanum (*only to adults*) will stop it more or less for a time. This, however, would be the worst possible thing to give, were the cough attended with much spit, as in bronchitis, inflammation of the lung, &c. It is the matter coming up from the lung that is the irritating agent in such cases. Laudanum and other similar soothing drugs would simply blunt the nerves to the presence of the matter, which would not be expelled, but be allowed to remain in the tubes, and might by blocking them seriously aggravate the state of the patient. In such cases what is desired is to aid in the expulsion of the matter without serious efforts of coughing. For this purpose warm applications to chest and throat are valuable, and drugs like ipecacuanha wine (10 to 30 drops) and syrup of squills.

A very intractable form of cough is produced by relaxed throat and elongated uvula. The long uvula touches the tongue and maintains a constant tickling. The sprays recommended for clergyman's sore throat (p. 287) are useful here. The best treatment, however, is to snip off a piece of the too long uvula with scissors, which occasionally causes the cough to stop as if by magic.

Difficulty of Breathing (*Dyspnœa*, Greek *dus*, difficulty, and *pneo*, to breathe).—Difficulty

of breathing attends many affections of respiratory organs, and occurs in very varied degree. It may amount to mere increased rapidity of breathing and shortness of breath on the slightest exertion, owing to general feebleness, as in anæmia, or to disease of the heart, or chronic disease of the lung, and may produce little discomfort. More than this it may be, up to that degree in which breathing is a constant struggle, agonizing almost in its character, when every muscle that can possibly aid in drawing air into the lungs is called into play, nostrils working, muscles of neck straining, and chest heaving, the lower part being frequently sucked in. In children the movement of the nostrils is often the first indication of some interference with easy breathing, and later excessive heaving of the belly and sucking in of the lower ribs become marked. Accompanying the severe forms of dyspnœa are indications of the want of proper aëration of the blood, lividity of the surface of the body, blueness of finger nails, coldness of the extremities; and when the struggle is severe the perspiration stands in beads or streams down the face. When the difficulty is considerable and lasting, without being so extreme, the want of proper purification of the blood produces headache, languor, and dulness. In asthma (p. 273) the difficulty of breathing comes on in spasms, is often excessively severe, seeming to threaten suffocation, and gradually passes off after a time.

Dyspnœa is of various kinds. Sometimes it is due to obstruction in the air passages because of swelling, the formation of false membranes, dropsy of the larynx (p. 270), the presence of foreign bodies or tumours, or accumulation of secretion, as in bronchitis, or blocking of the lungs, as in pneumonia (p. 274) and consumption, &c. It is a common symptom of valvular disease of the heart (p. 239). It may be of nervous origin, as in asthma; and it must not be forgotten that it may be associated with a cause quite outside of the chest, owing, for instance, to tumours or accumulated fluid in the belly pressing up the diaphragm (p. 253), and thus interfering with expansion of the chest. In this way an overloaded stomach or a congested liver will cause shortness of breath.

Suffocation (*Asphyxia*, Greek *asphuxia*, a stopping of the pulse) is an advanced stage of dyspnœa. It is the result of want of oxygen in the blood. Usually this want is the result of the exchange between the gases of the blood and those of the external air (p. 260) being interfered with, so that not only does the deficiency of oxygen become marked, but there is an accumulation of carbonic acid gas in the blood. Excess of the latter gas in the blood would not, however, produce suffocation, provided sufficient oxygen were at the same time supplied; but it would produce the signs of narcotic poisoning, namely, profound sleep, and complete insensibility that might end in death. It is the lack of oxygen that produces the results to be described.

It is evident that asphyxia may be brought on in two ways: (1) either by the person being in an atmosphere incapable of supplying anything like the due amount of oxygen, or (2) while the atmosphere is of a proper kind some obstacle exists to the admission of the air to the blood. The latter event may happen because the air cannot be introduced to the lungs because of paralysis of the respiratory movements, because the lungs have become blocked up and cannot admit it, or because some obstruction exists in the air passages. Thus some foreign body may have fallen into the windpipe, or the windpipe may be closed by strangulation, or the chest may be prevented moving, as, for instance, happens when a mass of earth falls upon a person burying him up to the neck.

Asphyxia may occur suddenly by sudden complete interruption to the breathing, or may come on more slowly, as it does in some diseases, difficulty of breathing becoming worse and worse till it passes into a state of suffocation. However it occurs its symptoms are the same.

Symptoms.—Three stages are recognized in the progress of the process of suffocation. In the *first stage* there is great difficulty of breathing, in which every muscle is exerted in the effort to get air into the lungs, the veins of the surface of the body becoming distended and livid. This laboured breathing passes into general convulsions, in which nearly all the muscles of the body partake, the fæces and urine being passed by the convulsive movements. Then follows the *second stage*, in which the animal or person lies quiet and insensible, the pupils being widely dilated, the muscles all relaxed, and no movement is capable of being called forth. Following this is the *third and final stage*, when long and slow efforts to breathe in are made at long intervals, and become gradually like convulsive gasps, until with one final gasp, head being thrown back, back arched, nostrils dilated, and mouth widely open, death occurs. The heart ceases only after all other movements have stopped. If the obstruction

to the breathing be sudden and complete the stages are all passed through in the course of three to five minutes, and the heart stops in between seven and eight minutes after deprivation of air. In experiments performed to ascertain after what lapse of time recovery could occur, it was found that a dog, simply deprived of air for four minutes, recovered; but if deprived of air by submersion in water, recovery was impossible after one and a half minutes, apparently because the entrance of water had prevented the restoration of the lung's function.

Treatment of suffocation consists in removing, if possible, any obstacle to the entrance of air. If that has been accomplished the next thing is to cause air to enter the chest. When the case has not gone too far, movements of respiration may be excited by dashing cold water over the chest, or by lashing the chest with towels dipped in cold water. If no movements can be excited in this way air can still be caused to enter the lungs by artificial respiration (see ACCIDENTS AND EMERGENCIES). Sometimes breathing can be induced by electric shocks properly applied to the nerves of breathing. Recovery need not be despaired of unless the heart has ceased to beat.

Apnœa (Greek *a*, not, and *pneo*, I breathe), cessation of breathing, is sometimes used to mean asphyxia. Really it means stoppage of breathing, because of *excess* of oxygen in the blood, not because of deficiency. Let any one take quickly a series of deep breaths. The desire for breathing will pass away for a little, and a slight interval will elapse before it returns. The first few breaths after the interval will be feeble and shallow. The condition of apnœa has been produced.

Lividity (*Cyanosis* (Greek *kuanos*, blue), *Blue Disease*) is only a symptom, and indicates want of proper aëration of the blood. If the blood has not its due supply of oxygen it becomes of a dark hue, and still more dark if it contains an excess of carbonic acid gas (p. 216). In such circumstances the purplish blood will give a livid hue to the skin instead of the ruddy colour of health, and the livid colour is most quickly seen in the lips, tongue, and under the finger nails, though in marked cases the whole skin exhibits the dusky colour. Any disease of the lung interfering with the due interchange of gases (p. 258) tends to produce it. It is most marked in a defective condition of the heart, dating from birth, owing to which impure blood from the right side is permitted to pass directly to the left side without previously passing through the lungs. It is of course a conspicuous symptom of suffocation.

AFFECTIONS OF VOICE AND SPEECH.

The voice may be affected in various ways. It may be weakened, that is, its *force* diminished, by any disease which reduces the general strength, or the extent of the movements of the vocal cords may be voluntarily lessened because of pain any vigorous movement would call forth. Its *pitch* is variously affected, not only by the condition of the cords themselves, but also by the state of the air-tubes above them. The cords may be thickened by swelling, the result of catarrh, or the mucous membrane may be relaxed, so that the usual rapidity of vibration or stretching of the cords cannot be produced, and the pitch will be lowered. But the larynx and throat may be similarly thickened and relaxed so as to be unable to resound to sounds of the same pitch as formerly. Singers and public speakers ought to observe that enlarged tonsils (p. 156) act in this way, and markedly lower the pitch of the singing voice, or cause a painful sense of straining when singing or speaking for any time. Some celebrated singers, who have had enlarged tonsils removed, found with delight that after the operation they were capable of taking notes fully half an octave higher than formerly. The *quality* of voice is also affected in various ways, the most marked alteration being when hoarseness or huskiness is produced.

Hoarseness is due to irregular and imperfect bringing together of the vocal cords, and is most frequently due to swelling of the mucous membrane of the cords, to thickening, and to excessive secretion of mucus in their neighbourhood, such as common cold will readily induce. Various other reasons may exist to account for it, such as inflammation, ulceration, contraction, &c., of the cords or in their immediate neighbourhood. Most obstinate hoarseness is produced by syphilitic thickening and ulceration, and by tubercular ulceration, such as often occurs in the progress of consumption. Paralysis of the cords, owing to pressure on the nerves supplying the muscles of voice, or other nervous disease, is also a cause.

Treatment, to be of value, must have regard to the condition of the cords and larynx, and the condition can only be properly ascertained by examination with the laryngoscope (p. 263). The hoarseness that comes on quickly with pain on

any attempt to speak, as a result of ordinary cold, should be treated with soothing remedies, the inhalation of the steam of boiling water, warm poultices to the neck, &c. Later, when all pain has passed away, and only the hoarseness remains, the sprays recommended for clergyman's sore throat are useful.

Clergyman's Sore Throat (*Dysphonia clericorum*).—This is an affection to which not clergymen only, but teachers, lecturers, and all public speakers generally are liable. It consists of a chronic thickening of the mucous membrane of the throat and larynx. The membrane is thickened and relaxed, and pours out an excessive quantity of thickened mucus which is brought away with difficulty. There is a feeling of great discomfort in the throat, especially after speaking. The person feels as if a veil had been drawn over his speaking apparatus, as if something were present which by coughing or hawking he could dislodge, and he dislodges it only to find it again collect. It is the mucus that gives this impression.

Treatment is difficult, since the chief element in the best would be absolute rest for some time, and that is generally impossible. The person should always try to avoid straining the voice, and specially if he is affected with the slightest cold, as loss of voice lasting for some days might thereby quickly arise. His general health should be maintained as well as possible by stomach, bowels, skin, and kidneys being kept in good order, and by the use of some tonic medicine such as quinine and iron, or phosphorus quinine and iron (p. 113) if necessary. For the throat local applications are needful. Weak alum or chlorate of potash gargles are useful (see PRESCRIPTIONS); but these never get down to the vocal cords. For the medicine to reach the cords it must be drawn in with the breath in the form of spray. To effect this atomizers or spray producers (see MEDICAL AND SURGICAL APPLIANCES) are employed, by which the liquid is dispersed in a cloud of small particles by a strong current of air. The point of the atomizer is held within a few inches of the mouth. The mouth is widely opened, the tongue being kept down as much as the person can, and when a full stream of spray is directed into the mouth the person draws a long deep breath and thereby introduces the material into the larynx and windpipe. Various drugs may be used, of various strengths, with the spray producer. In the appendix on PRESCRIPTIONS—GARGLES, &c., some are mentioned. A useful one consists of tincture of steel, 2 fluid drachms, glycerine, ½ ounce, rose water, 1½ ounces, and water to 4 ounces. This is put into the bottle of the atomizer full strength or diluted with water if necessary. If required it may be made stronger by the addition of one or more drachms of the tincture of steel.

In very troublesome cases, however, nothing equals the direct application of some solution to the vocal cords and affected parts by means of a brush. This only an experienced and dexterous surgeon can accomplish properly.

Loss of Voice (*Aphonia*, Greek *a*, not, and *phōnē*, the voice) sometimes is the result of severe cold; ulceration and other changes of the vocal cords cause it. Paralysis of the cords makes it complete, and the paralysis is not infrequently the result of the nerves of voice being involved in some growth or pressed upon by a tumour, aneurism, &c. In women loss of voice without any structural changes is frequent, being due to hysteria or other nervous condition. Nervous women, plagued with uterine troubles, are subject to it, and the loss of voice is not permanent but temporary, relapses being common. Cases are on record where no word was spoken for months or years, hysteria only being the cause.

Treatment it is needless to specify particularly, considering the necessity of some one being consulted who can determine the exact cause. In loss of voice from cold, however, warm applications to the neck, a blister over the top of the breast-bone, inhalation of steam, &c., are useful.

The Care of the Voice deserves a word. Anyone who reads the description of the vocal apparatus on pp. 261, 262 will understand how exquisite are the adjustments of the various parts for even ordinary speaking, and how the slightest alteration in the proportions of parts by cold, swelling, &c., will seriously affect the whole instrument. It should, therefore, be evident that anything that overstrains the parts, too prolonged use of the voice, talking or singing in too high a key, screaming, &c., must have a bad effect on the vocal instrument; and that such overstraining will be most easily accomplished when the person is fatigued, in indifferent health, ill-nourished, or when the parts are affected by cold, &c. Therefore, wherever possible, in such circumstances, the voice should not be used at all. Most people become impatient at the excuse of those who can sing,

when a slight cold is offered as a reason for refusing to comply with a request or to fulfil an engagement, but it ought not to be so. A cold not perceptible to anyone is yet sufficient reason for the singer refusing to exercise his or her gift. Indeed the singer who had not such regard for his or her voice would speedily have little voice worth regarding. Singers and public speakers ought also to pay attention to the condition of tonsils, &c., as they, if enlarged, materially affect the pitch and quality of the voice.

Stammering or Stuttering implies usually a sudden check to the utterance of words followed by a longer or shorter pause, during which the person makes sundry attempts to utter the word at which he was stopped. It is a spasmodic affection, and it occurs most commonly in the utterance of the consonantal sounds p, b, t, d, g, and k, though also with s, z, sh, m, n, v, y, w, f, and more rarely with vowel sounds. As a rule persons do not stammer when whispering or singing. It does not seem to depend on any organic defect, but partakes more of a nervous affection, the complex series of muscular movements involved in speech not being properly subordinated to one another and controlled.

It is a defect which shows itself between the age of four or five and puberty, and may come on as the result of feeble health after illness, or owing to fright or excitement, and *sometimes by imitation.*

Its treatment consists of careful, patient, and determined training. The stammerer must be taught to speak slowly and deliberately, must practise the sounds at which he stammers, and must learn to restrain all tendency to become excited and hurried when nearing the sound which presents difficulties. Practising reading aloud in the presence of some one who will check at once any departure from slowness and deliberateness of utterance is one of the best possible aids. The stammerer has also to train himself to regulate the movements of his breathing, as the tendency is to run on until a stop for want of breath is necessary. It is only by such careful and long-continued training that the defect can be remedied.

Section X.—THE KIDNEYS AND BLADDER.

A. THEIR ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

The Kidneys: *Their structure*—tubuli uriniferi—Malpighian bodies or glomeruli;
Their functions—the formation of the urine;
The excretion of the kidneys—the urine—its characters and chemical constitution—urea—unusual constituents (albumen, sugar, bile, blood).

The Ureters and Bladder:
The Ureters;
The Bladder—its structure and functions—the mechanism of the expulsion of urine.

In the previous section the method by which the blood is purified to the extent of being deprived of its excess of carbonic acid gas, through the agency of the lungs, is described. But carbonic acid gas is not the only waste substance derived by the blood from the tissues. There are others, as important, the result of the decomposition in the body of nitrogenous or proteid (p. 132) substances. If they are allowed to remain in the body death is the result. To separate these nitrogenous waste substances there must be some special apparatus. That special apparatus is found in the kidneys and their attendant organs, urinary bladder, &c. They are, therefore, exclusively excretory organs—organs solely devoted to the purpose of separating from the blood substances to be expelled from the body. The substances are separated in a liquid form, the urine; and as the urine is formed slowly, after passing from the kidney it is collected in a reservoir—the bladder—until some quantity has accumulated, when it is discharged by a voluntary effort.

THE KIDNEYS.

Their Structure.—The kidneys are two in number, and are situated in the cavity of the belly, one on each side of the back-bone, between the eleventh rib and the crest of the haunch-bone. The liver is above the right kidney, the spleen (p. 204) above the left; while

both lie close against the back wall of the belly, so that the intestinal canal is in front of them. The human kidney is about 4 inches long, 2 inches broad, and 1 inch thick, and weighs usually about $5\frac{1}{2}$ ounces. The shape of the human kidney is the same as that of a sheep, or rabbit, and is well known. The connections of the kidney are shown in Fig. 137, which represents the outline of the belly, opened, the intestinal canal being removed. A kidney appears on each side of the back-bone, blood-vessels being connected with each, and from each a tube—the **ureter**—passes downwards to the bladder, situated in the cavity of the pelvis.

If a kidney be cut open in the direction of its length an appearance exhibited in Fig. 138 is seen. The ureter (U) where it joins the kidney expands into a wide cavity (P), which is called the **pelvis** of the kidney. Into the pelvis conical processes of the fleshy substance of the kidney project. The processes are called pyramids, or the **pyramids of Malpighi**, after the anatomist who described them, and in the human kidney there are about twelve of them. The point of each pyramid is invested by a part in continuation of the pelvis, which surrounds it like a cup or calyx. Now the fleshy-looking substance of the kidney consists of very fine

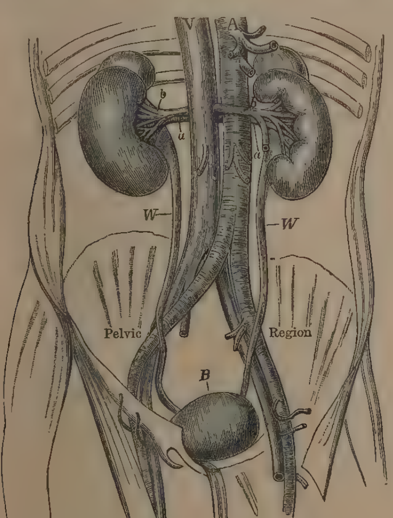


Fig. 137.—The Situation of the Kidneys.

A, Aorta; V, Vena Cava; B, Bladder; W, Ureters. Branches of the aorta (*a a*) are seen going to the kidney, and veins from it (*b b*) are shown joining the vena cava.

tubes, the **tubuli uriniferi** (or urine-carrying tubules). Towards the surface of the kidney the tubules run a very irregular course, but towards the centre they run a straight course. The distinction between the part of the kidney containing the twisted tubes and that contain-

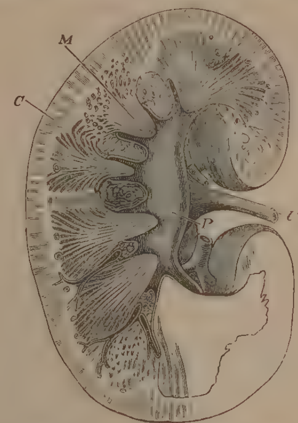


Fig. 138.—A Kidney opened in its length.
C, Cortical portion; M, Medullary portion; P, Pelvis; U, Ureter.

ing the straight tubes is easily made out with the naked eye, the former part appearing granular, and being called the **cortex** or rind, while the central parts appear streaked, and are called the **medulla**, or marrow-like. The distinction is represented in Fig. 138, where it is evident that the medullary portion is formed of the pyramids whose bases rest on the cortex.

It is in the tubules that the urine is formed. The tubules all ultimately open by a group of mouths on the surface of the pyramids, so that the urine formed in them finds its way into the pelvis of the kidney, and thence down the ureter into the bladder.

The **tubuli uriniferi**, of which the bulk of the substance of the tissue is made up, are very fine tubes, about the $\frac{1}{600}$th of an inch in diameter. They run a very irregular course, undergoing various changes in different stages. They begin in the cortical or outer portion of the kidney in a blind extremity which is widened into a pouch or capsule. Into the capsule, as will be noted hereafter, a bundle of capillary blood-vessels projects. From this expanded extremity the tubule passes off by a narrow neck, and winds a very irregular course in the cortex, twisting and turning upon itself for some distance. This part of the tubule is called the **convoluted tubule**. Then, after a short portion in which the tube is more spiral than twisted, it suddenly contracts to a very narrow diameter and courses straight on towards the central or medullary part of the kidney into

which it enters. But shortly after entering the medullary region it turns upon itself and proceeds, still in a more or less straight direction, and as a very narrow tube, back into the cortex. This narrower portion that doubles on itself is called the **looped tubule** of Henle, after the observer who first described it. Ultimately the tubule mingles again with the convoluted tubules, and again becomes itself wider and wavy or spiral. This second spiral part of the tube leads into a wider straight tube which passes down through the cortex to the medulla. As it proceeds through the medulla it joins, now and again, similar tubes at

Fig. 139.—Representation of the Tubules and Blood-vessels of the Kidney.

On the right-hand side 1 points to the widened end of a tubule (in the cortex) containing a tuft of blood-vessels. The tubule passes off as the convoluted tubule (2), then it suddenly becomes straight (3) and passes down to the medullary region, turning back at 4 and passing back (5) to the cortex, where it becomes wavy (6), and ultimately joins a straight tubule 7, running downwards (8, 8) through the medulla to open at 9 on the point of a pyramid into the pelvis of the kidney (see Fig. 138). On the left-hand side of the figure the relation of tubule and vessels is shown: *ar* is a branch of the renal artery, from which a twig (*a*) passes off to enter the widened end of a tubule; *e* points to the vessel leaving the tubule and breaking into a meshwork of capillaries, which finally form again into one vessel, joining a branch of the renal vein (V). The artery is shown giving off other twigs to other tubules. At the side, C indicates the cortical region, M, the medullary region, and B, the layer bounding the two.

acute angles or is joined by them, becoming thereby gradually wider until it opens on the surface of a pyramid. Fig. 139 gives a view of the passage of a tubule from its expanded extremity in the cortex to its mouth on the point of a pyramid.

In the different parts of their course different

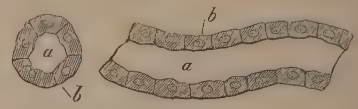


Fig. 140.—Very highly magnified view of section of a tubule, cut across and in its length. *b*, **cells;** *a*, **channel of a tubule.**

diameters of the tubule have been noticed, and there are other corresponding differences. The tubules are formed of a delicate membrane whose inner surface is lined with cells. In some parts of the tube the cells are large and cloudy, presenting the appearance of cells engaged in the active work of secretion. In other parts they are small and insignificant, evidently not for secreting purposes, but simply to act as a lining to the tube. Fig. 140 shows the appearance of a cross section of a part of a convoluted tubule and of a part of such a tubule opened up, the cells being large and of the actively secreting kind.

The **Blood-vessel Arrangements** of the Kidney.—It has been mentioned in passing that the expanded ends of the tubules contain bundles of fine blood-vessels. Each kidney receives an artery from the main arterial trunk—the aorta—as it passes through the belly. The artery after entering the kidney splits up into various branches, which penetrate into the substance of the kidney. They reach the junction between the cortex and medullary regions, from which twigs pass up between groups of the convoluted tubules towards the surface of the kidney. On their way they give off branches. These branches penetrate the expanded ends of the tubules and immediately break up into a ball or tuft of capillaries, for which the expansion serves as a covering or capsule. The ball of capillaries is called a **glomerulus**; and it, together with its capsule, forms a **Malpighian** body of the kidney. The capillaries ultimately reunite to form a small vessel which passes out of the capsule, and speedily thereafter that outgoing vessel gives rise to a number of capillary blood-vessels which ramify over the convoluted tubules, affording, we may suppose, nourishment to their cells. These capillaries are then gathered together to form a small vein which joins other veins till large veins are formed, whose junction forms one large vein which goes off from the kidney, carrying away the blood

brought by the artery and pouring it into the vena cava (Fig. 137). Other arterial twigs proceed from the junction of medulla and cortex into the region of the pyramids of straight tubes, over which they ramify, to end in veins as the others. The chief point to notice is that the vessel that enters the capsule—the **afferent vessel** (Latin *ad*, to, and *fero*, I carry)—gives rise, directly or indirectly, to two sets of capillaries, those of the glomerulus and those that proceed from the vessel that issues from the capsule—the **efferent vessel** (*ex*, out of, and *fero*). *The outgoing vessel is smaller than the ingoing;* and the significance of this will appear immediately. Fig. 141 represents a Malpighian body with its entering and issuing vessels, surrounded by the capsule, the blind end of a tubule. Fig. 139 is a representation of the afferent vessel (1), arising from an arterial branch, forming the glomerulus, which ends in the efferent vessel (2), whose capillaries ramify over the convoluted tubes and end in a venous twig. In the Malpighian body the tuft of vessels is covered with a layer of small cells, so also is the inner surface of the capsule.

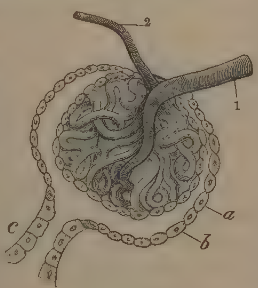


Fig. 141.—Malpighian Body of Kidney, with its tuft of vessels.
a and *b*, cells of capsule formed of widened end of tubule *c*. The wide vessel is the afferent; the narrow one is the efferent.

These details of structure show, to a great extent, how the kidney discharges its duties in separating waste matters from the blood, and what is the nature of the apparatus by which this is effected.

The Functions of the Kidney.—The business of the kidney is to separate certain substances from the blood which have gained access to it in its course through the body, and are the result of the decompositions effected in the tissues by their activity. The chief of these substances removed by the kidney is urea, a solid crystalline body. But the excretion of the kidney is a fluid—the **urine**—in which urea and various other organic and inorganic substances are in solution. What is known of the structure of the kidney indicates that in the formation of the urine there are two processes at work. One process is performed in the Malpighian bodies. An artery enters the capsule of the body and immediately breaks up into a tuft of capillaries. Now the blood is always exerting considerable pressure on the walls of the vessels, and the capillary vessels are very thin walled. One would at once conclude that fluid would ooze through the thin capillary walls and be received in the capsule. The capsule is the expanded end of a uriniferous tubule, so that the escaped liquid would find its way down the tubule, and so into the pelvis of the kidney, into which the tubule opens. As it collected in the pelvis it would flow into the ureter and so reach the bladder. In short, the structure of the Malpighian body suggests that it is a sort of filter, the filter being formed by the thin walls of the blood-vessels of the tuft with the fine layer of cells which covers them, having on one side of it blood under pressure and on the other side the cavity of the capsule (see Fig. 141). As the blood streams through the capillary tuft, fluid filters from it into the capsule, and the greater the pressure of the blood the more fluid will be passed through. Force and confirmation are given to this view by the fact that the vessel, which the capillaries of the Malpighian body form, and which leaves the capsule, is narrower than the entering artery. The supply pipe is larger than the escape pipe; blood passes into the Malpighian body more readily than it escapes from it. Consequently the blood in the capillaries will be at greater than usual pressure, and filtration of liquid from it will be encouraged. The structure of the apparatus, therefore, suggests that one part of the process of urine formation consists in the separation from the blood by filtration of certain of its fluid constituents. This does not, however, appear to be all. As soon as the blood has passed out of the Malpighian bodies in the efferent vessel it is distributed over the convoluted tubules by fine capillary blood-vessels into which the outgoing vessel breaks up (see Fig. 139). Now the convoluted tubules consist of a very delicate wall lined within by large active cells (Fig. 140), and blood is brought in thin-walled vessels into intimate connection with the tubes. These are just the conditions of secretion. The active cells of the tubules are separated from nourishing blood only by the thin walls of the tubes and vessels. It is therefore probable that the cells separate certain substances from the blood, which they work up and then pass into the tubule among the fluid filtered into the capsule and finding its way down towards the ureter. It has been, therefore, concluded that the process of

formation of urine consists of two parts—(1) of a separation of fluid parts of the blood *by filtration* in the Malpighian tufts, and (2) of a separation *by active cells* from the blood of probably more solid substances, which are added to the filtered fluid in its course down the tubules.

To this view of the action of the kidney there is one great objection. The blood is an albuminous fluid (pp. 216–217). Careful experiments have shown that if an albuminous fluid be placed on a filter the liquid that passes through contains albumen though in much less quantity than the original fluid, and that if the solution on the filter contains saline substances dissolved in it, these hinder the passage of the albumen, though they do not arrest it altogether. The experiments have also shown that as more pressure is exerted on the fluid on the filter more albumen will pass through with the fluid. If, therefore, the urine is largely a filtration from the blood under pressure, the fluid ought not only to contain some of the salts of the blood, but also some of the albumen, though less albumen ought to exist in the urine, because the blood is a saline solution, than would be if the blood were only albuminous and contained no salts. In health, however, the urine contains not a trace of albumen. Indeed, if a physician finds albumen in the urine of a patient he regards it as a grave sign of disease. It is then not easy to understand why, if the urine is mainly a filtration from the blood, it does not in health contain albumen. A view which explains this curious fact is that the fluid, as filtered through the vessels of the Malpighian tufts, is albuminous, but that, as the urine passes down the convoluted and other parts of the tubules, the active cells, lining their channels, seize on the albumen and pass it back into lymphatic channels, so that it may be again restored to the blood. When, therefore, the urine reaches the end of the tubule, and flows into the pelvis of the kidney, it has been entirely deprived of the albumen it possessed as it left the Malpighian capsule. It may be added that by this view one is able to explain various forms of severe disease of the kidney grouped under the term Bright's Disease, of which one of the most important symptoms is the occurrence of albumen in the urine. If the pressure of blood be very greatly increased in the capillaries of the Malpighian bodies so much albumen may thereby be passed through that the cells are not able to pick it all up, some escapes them and is detected in the urine. Again, the cells may be paralysed or otherwise rendered unfit for their duty by some condition of the blood, or they may have been destroyed by disease. In such a case though the albumen filtered from the blood is in ordinary quantity it is not picked up by cells of the tubules, and again its occurrence is detected in the urine. (Refer to the description of Bright's Disease in the second part of this section, p. 295.)

The Excretion of the Kidney—the **Urine.** The characters of the urine excreted by the healthy kidney are well defined; and they undergo marked alterations in disease. It will, therefore, be of value to state here the characters and chemical constitution of healthy urine and the chief alterations urine undergoes in disease. This will be of great value in understanding the results of the diseased conditions of the kidney described in the second part of this section.

Urine when freshly passed is of an amber **colour**, clear and transparent, and with a peculiar aromatic **odour** and of slightly acid **reaction.**

Its **specific gravity** is usually about 1020.

The **quantity** passed in 24 hours by a healthy adult man is between 50 and 60 fluid ounces. It varies not only according to the quantity of water taken in by the mouth, but according to the external temperature and the amount of exercise. The kidneys and skin co-operate to this extent, that if much water is removed by the skin as sweat, as in warm weather and after exercise, less is expelled by the kidneys. In cold weather the skin is less active, and a greater quantity of water will be produced by the kidneys. Nervous influences also affect the quantity. Thus after hysterical attacks a large quantity of clear urine is often passed.

Its **chemical constitution** is shown in the following table:—

	In 1000 parts.	Quantity in 24 hours varying between
Water	958	
Solids	42	
The solid constituents are—		
Urea	23·3	400 to 600 grains.
Uric acid	0·5	5 ,, 12 ,,
Chloride of Sodium (common salt)	11·0	150 ,, 200 ,,
Phosphoric acid	2·3	48 ,, 54 ,,
Phosphates of lime and magnesia	0·8	11 ,, 16 ,,
Sulphuric acid	1·3	23 ,, 38 ,,
Ammonia	0·4	9 ,,
Free acid	2·0	30 ,, 60 ,,
Various other substances—Kreatinin, hippuric acid, &c., in very small amount.		

The average quantity in 24 hours is of water 52 ounces, of solids 840 to 920 grains.

Gases, principally carbonic acid gas, nitrogen and oxygen being in very small quantity, are also contained in urine to the amount of nearly 16 per cent.

The solid constituents consist of two classes of substances: (1) inorganic salts, namely, common salt (chloride of sodium), sulphates, and phosphates, and (2) organic bodies, bodies containing nitrogen, namely, urea, uric acid, hippuric acid, kreatinin, &c. It is instructive to observe the sources of these substances. Chlorides occur in all the fluids of the body; sulphates arise from the decomposition of albuminous bodies; and phosphates have as their source albuminous bodies, the phosphates existing in bone, and phosphorus present in nervous structures. An excess or diminution in the quantity of any of these substances cast out of the body may thus aid in the recognition of a disease. Thus the quantity of phosphates in the urine is increased in diseases of nerve-centres and of bone.

The chief constituents, however, are the nitrogenous, urea and uric acid, the former specially, of which a large amount is excreted, as indicated in the table. Urea contains the four elements, nitrogen, hydrogen, oxygen, and carbon, nitrogen forming half its weight. While, therefore, the lungs expel from the body carbonic acid in particular, the kidneys expel nitrogen. Both of these substances show decompositions going on in the body, the carbonic acid being the result of the breaking down of starch, sugars, fats, and albumen also, while urea and uric acid are the products of the decompositions of nitrogenous bodies only, of which albumen is the type. The quantity of urea is always increased by a diet rich in albuminous food-stuffs. It is the last stage in the oxidation process which such food-stuffs undergo in their transit through the body. If it be not excreted by the kidneys a condition known as **uræmia** arises, described on p. 296. Uric acid probably represents a stage in the oxidation of nitrogenous bodies not so far advanced as urea. In human urine its quantity is very small (see table). In fevers and other unhealthy states of body its quantity is greatly increased, and since it is more easily dissolved in hot solutions than in cold, when the urine cools it becomes deposited in the form of a brick-red precipitate, making the urine muddy. When in excessive quantity, as in rheumatism and gout, it may form deposits in kidney or bladder, leading to the production of "stone," and in gout it is deposited in the fibrous structures around joints in the shape of chalk-stones.

Some colouring matter is also present in urine.

Unusual constituents of urine are albumen, sugar, bile, and blood. When albumen is present in urine it, as a rule, indicates some disease of the kidney, to which the term **albuminuria** has been applied. The presence of sugar indicates the disease **diabetes.** Both diseases are commented on in the second division of this section (pp. 295, 302, 303). Bile is another unusual constituent of urine, appearing in jaundice (p. 198). The appearance of blood is spoken of on pp. 302, 304.

THE URETER AND BLADDER.

The Ureter is the tube which leads from the kidney to the bladder, and is shown in Fig. 137 (p. 289). It enters the bladder at the lower part behind and to the side of the middle line. In length it is from 16 to 18 inches, and is about the size of a goose-quill. It is formed of an outer fibrous coat, a middle muscular coat, and an inner mucous lining with epithelial cells (p. 16) on its free surface. To its walls blood-vessels and nerves are distributed. Its channel is narrow, and it can be easily understood that if a stone has been formed in the kidney, and gets forced into the ureter, its passage down that channel will be accompanied by excruciating pain. The urine is conveyed from the kidney to the bladder by a wave of contraction passing along the ureters from the kidney to the bladder. It reaches the bladder not in a constant stream, nor yet in occasional gushes, but drop by drop, so that it gradually accumulates there.

The ureters open slantingly into the bladder, so that the urine finds its way into the bladder easily, but could not be readily forced up the tube from the bladder.

The Bladder is situated in the pelvis (p. 22, and Fig. 137, p. 289) in front of the termination of the large bowel. Its front face is in contact with the inner surface of the junction of the pubic bones (*sp.* Fig. 21, p. 22); and when full the top of the bladder projects above the bone. It is in this position that pain is felt when the bladder is strained by overfulness. When full the bladder is pear-shaped, when empty it is collapsed and lies low in the pelvis. It consists of three coats, an outer fibrous layer, a middle of muscle, of the unstriped variety, whose fibres run in bundles forming an irregular network, and an inner mucous layer with many layers of large epithelial cells on its surface. The peritoneum (p. 130) also in part covers the organ. From the small end of the bladder a canal passes—the **urethra,**

into which the bladder opens, and by which it is put in communication with the outside. The narrow end is called the neck of the bladder, and is surrounded, at the junction with the urethra, by a special bundle of muscular fibres, called the **sphincter of the bladder.** Urine cannot escape from the bladder unless the guard of the sphincter is relaxed.

The functions of the bladder are to collect and retain the urine from the kidneys until a certain quantity accumulates, and then to expel it in a stream. The urine enters its receptacle from the ureters drop by drop, and when the bladder becomes distended its emptying is effected apparently by a reflex nervous act (p. 86). An impression passes to a centre low down in the spinal cord. An impulse is thus originated by which the sphincter muscle is relaxed and the muscular walls of the bladder caused to contract. The channel being open, the contraction of the walls exerts pressure on the contained fluid which is thus expelled. Nervous diseases may affect the act of expulsion. The tone of the sphincter may be lost, so that the urine cannot be retained, or the bladder may be paralysed so that the fluid cannot be driven out. Irritations may exist about the neck of the bladder, or about the private parts, or due to worms in the bowel, which set up the reflex act and lead to a too frequent desire to empty the bladder. This is a frequent cause of children wetting their beds at night, the irritation originating the whole process, while the children are unconscious of it. Again there may be some obstruction to the escape of the urine. Nevertheless, the process being involuntary, the contractions of the bladder are set up, all the more vigorously since they are opposed, and thus the severe pain arises that is common in this condition. To this extent the action is voluntary, in that the result of the process may, for a time, be prevented by the will, or may be aided by voluntary effort producing contraction of the walls of the belly, and thus exerting pressure on the bladder.

Section X.—THE KIDNEYS AND BLADDER.

B.—THEIR DISEASES.

Diseases of the Kidney:
- *Congestion;*
- *Inflammation* (*Nephritis*)—Bright's Disease—Uræmia;
- *Suppuration;*
- *Inflammation of the Pelvis of the Kidney* (*Pyelitis*);
- *Gravel and Stone*—Renal Colic;
- *Dropsy;*
- *Rare Diseases* of the Kidney—Cancer—Tubercle—Tumour—Movable Kidney.

Unusual Conditions of the Urine:
- *The Examination of the Urine*—the detection of albumen, sugar, bile, blood, &c.
- *Albumen in the Urine* (*Albuminuria*);
- *Polyuria* (*Diabetes Insipidus*);
- *Sugar in the Urine* (*Diabetes Mellitus*);
- *Blood in the Urine* (*Hæmaturia* and *Hæmatinuria*);
- *Chylous Urine;*
- *Suppression of Urine;*

Diseases of the Bladder:
- *Inflammation* (*Cystitis*);
- *Irritability;*
- *Paralysis;*
- *Retention and Incontinence* (dribbling) *of Urine* by the Bladder;
- *Stone* in the Bladder;
- *Cancer and Tumours.*

DISEASES OF THE KIDNEY.

Congestion, Inflammation, and Suppuration—Bright's Disease.

Congestion of the kidney implies overfulness of the blood-vessels of the organ. This, it is plain, may be either because a much larger quantity of blood than usual is streaming into the kidney by the arteries, in which case the congestion is said to be *active*, or because, the usual quantity passing in by the artery, it is hindered in its escape along the veins, in which

case it is called *passive*. Active congestion may be the preliminary to fully developed inflammation; it may be the result of exposure to cold; it often is due to the irritant action of a poison circulating in the blood, such as that of scarlet fever, measles, or typhus, or the effect of the action of some medicine, Spanish-fly, turpentine, or cubebs. Thus irritation of the kidneys often occurs through the application of a fly-blister. The passive form arises when there is obstruction to the circulation, leading to accumulation of blood in the veins. Heart and lung diseases are frequent causes. Pressure on veins by a tumour will readily produce it, and thus in pregnant women the enlarged womb sometimes obstructs the flow of blood in the veins.

The **symptoms** are mainly connected with the urine, which may be increased in quantity and pale, while the patient complains of tenderness or some degree of heavy pain in the loins. Such symptoms would indicate active congestion. Usually, however, the quantity of urine is diminished, is high-coloured, and contains albumen, and sometimes blood, and what are called tube casts. The method of detecting these is described on page 302.

The **treatment** consists of rest in bed, hot applications over the loins or a warm bath, and a brisk dose of purgative medicine. But since the commonest cause of congestion is an obstruction to the circulation, its seat would require to be made out, and the treatment directed to aid its removal. That would imply an examination of heart and lungs, &c., which only a physician could properly perform.

Inflammation of the kidney (*Nephritis*, Greek *nephros*, the kidney—*Bright's Disease—Albuminuria*). There are various kinds of inflammation of the kidney dependent on the fact that the whole structure of the kidney is not at first attacked, the disease beginning at first only in the tubules (page 289), or in the blood-vessels (page 290), or in the fine connective tissue which acts as a framework for tubules and vessels; though after it has begun in one of these, it tends to pass to the others. Of late years different names have been given in order to signify in what portion of the kidney structure the inflammation has begun. All the various kinds are included under the general terms **Bright's Disease**, because it was Dr. Richard Bright, of London, who first, in 1837, showed the relation between certain symptoms, namely, the presence of albumen in the urine and dropsy, and alterations in the structure of the kidney. One symptom is common to all the forms of the disease, that is, the presence in the urine, in greater or less quantity, of albumen, which, as has been noted on p. 293, is never present in healthy urine. Hence another general term is sometimes employed to include the various forms of the disease, a term which simply points to the main symptom—albumen in the urine—the term **albuminuria**.

For the purposes of this work the simplest way of describing the various forms of inflammatory disease of the kidney will be to divide them into acute and chronic forms.

In **Acute Bright's Disease** it is the uriniferous tubules (p. 289) that are specially attacked. They become altered, and the cells which line them are swollen and cloudy. The flow of blood to the organ is excessive, so that it is congested. Fluid escapes from the vessels into the tubules, clotting there and so blocking the tubes, or blood may pass by rupture of the overloaded vessels. The cells tend to become fatty and to break down. The clotted material may be swept out of the tubes by the urine in the shape of casts of the tubes, as well as the diseased cells shed from the tubes and blood, so that these all appear in the urine when passed, and may be detected by appropriate means (see p. 302). The inflammation may so affect the kidneys that they are unable to discharge their function, urine ceases to be secreted, and the accumulation of waste matters in the blood causes death. The inflammation may cease before serious changes have occurred, and recovery then take place. It may gradually pass off, leaving blocked tubules, tubules stripped of their cells, blood-vessels thickened, &c., from which ultimate recovery may result so far as the patient's health is concerned, though the structure of the kidney has been permanently affected; or the disease may become chronic.

The commonest **cause** is exposure to cold and damp. It occurs frequently in the progress of scarlet fever, also during diphtheria, measles, typhus, and erysipelas, and other diseases. *It may follow excessive drinking.* Intemperate habits greatly favour its occurrence.

The **symptoms** of this acute attack are as a rule comparatively sudden in their onset. Chilliness followed by shivering fits and fever, accompanied by headache, thirst, dryness of the skin, sickness and vomiting, are the indications of some serious disorder. The seat of the disease is specially marked out by aching across the

loins, it may be mere uneasiness or dull pain. Dropsy, however, is one of the most important signs. It comes on often rapidly, and is specially observable in the face, which becomes puffy, and has a peculiar blanched look. It is earliest seen in the eyelids, and is also common about the ankles, and may be so great as totally to alter the appearance of the patient. The urine undergoes decided alterations. It is diminished in quantity, though it may be passed more frequently than usual, is high-coloured, and has a copious sediment. Examination (p. 301) reveals the presence of albumen in greater or less quantity, blood also and tube casts (p. 302). A sense of heat and pain generally accompanies its discharge. In very severe cases the secretion of urine almost or quite ceases. This is termed **suppression of urine**, that is, no urine is formed by the kidney, and is to be distinguished from **retention of urine**, in which urine is formed, but some obstacle to its discharge exists. Resulting from suppression is the condition termed **uræmia**, a condition due to the retention of waste matters in the blood which the kidneys ought to separate out, but are rendered unable to do. Its symptoms are headache, mistiness of vision, noises in the ears, oppression, dulness, drowsiness, sometimes delirium and convulsions, and it ends in complete unconsciousness (coma) and death. Now, setting aside the symptoms of suppression of urine, the others that have been noted would leave no doubt as to the nature of the disease, and prompt treatment would be necessary. But the symptoms are not so marked in every case. In some cases previous signs of an inflammatory disease are absent and there is no marked pain, the symptoms being limited to dropsy and alterations in the urine. Nevertheless dropsy and scanty albuminous urine are sufficient to warrant the conclusion of the presence of Bright's disease. The symptoms of recovery are lessening of the dropsy, increase in the quantity of the urine, which contains a diminishing quantity of albumen, the skin becoming more moist and of a healthier colour. Recovery may take place speedily within one or two weeks, or may be gradual, occupying several weeks or even months, or the case may pass into a chronic form.

Treatment. — The patient should be kept strictly to bed, clothed in flannel, and his room should be kept warm. Hot applications, poultices containing mustard, if the attack is acute, are useful over the loins; but fly-blisters or turpentine cloths should not be used. The action of the bowels and skin should be aroused. This is done by giving from 20 to 60 grains of the compound jalap powder, repeated every morning or every second morning, as seems desirable. The action of the skin is aided by doses of solution of acetate of ammonia (a dessert-spoonful) and spirit of nitrous ether (half a tea-spoonful) repeated every three or four hours. But, for this purpose, nothing is so useful and so safe as a hot pack. The patient is rolled, naked, in a blanket, wrung out of hot water, and is then surrounded by warm dry blankets. He should be kept in it for an hour or much longer if he feels comfortable. On the hot pack being removed the person should be quickly dried with warm cloths and enveloped in warm flannels. In the absence of medical advice this is the simplest and safest treatment to pursue whenever the symptoms seem urgent. The patient ought also to have plenty of water, lemonade, barley-water, milk, &c., to drink to help in washing away the material that tends to block up the tubules of the kidney. His diet should be mainly of milk and similar light material. On recovery great precautions must be exercised, as the least exposure might produce a relapse. Flannels should be worn, good nourishing food given freely, and quinine and iron administered to restore strength and tone.

Persons ought to be warned, however, that this is a most serious disease, even in its apparently mildest forms, and that, whenever possible, nothing should stand in the way of a sufferer from it being placed at once under responsible medical treatment.

Chronic Bright's Disease exists in a variety of forms (1) as a **chronic affection of the tubules**, the consequence of the acute attack just described, (2) in the form of **cirrhosis** or **thickening**, producing what has been called the **granular, contracted, or gouty kidney**, and (3) the **waxy or lardaceous kidney.**

The *first form* is frequently the result of taking cold. In it the tubules are permanently affected, their epithelial cells being removed, and the tubes blocked with broken-down material, wasting of the kidney following in time.

Its **symptoms** are chiefly alterations in the character of the urine and dropsy. The urine is scanty, contains albumen, and the use of the microscope discovers in it numerous cells from the tubules, and casts of the tubules. The patient has a doughy, puffy look, the dropsy filling up the furrows of the face, and giving a smooth, glossy appearance. Outbursts of the acute attack are liable to arise, and inflamma-

tory attacks of other organs and affections of the heart and arterial vessels are not infrequent.

The *second form* is most frequently caused by abuse of spirituous liquors, specially whisky or brandy. It is also associated with gout and with lead poisoning.

In this form the connective tissue between tubules and blood-vessels is the chief seat of the alterations of structure. It is increased in amount and by its pressure on the blood-vessels diminishes their supply of blood while it causes wasting of the tubules. The whole organ becomes greatly reduced in size by the shrinking of the connective tissue.

Symptoms of the disease may not be evident for a long time, unless they are symptoms of digestive trouble, common in all forms of Bright's disease. Sometimes the patient seeks medical advice owing to failure of sight, when a careful examination of the eye reveals changes in the retina, the nervous coat at the back of the eyeball, associated with a diseased kidney, whose existence was not before suspected. Dropsy may be absent or very slight. The urine is pale, increased sometimes in quantity, but does not always contain albumen, though usually in small amount. Associated with this form of Bright's disease in particular are alterations in the heart and arteries; affections of the lungs are common, bronchitis, pleurisy, &c., and uræmia, described in a previous paragraph, is the common cause of death. Recovery does not take place, but the person may live for many years, as the progress of the disease is very slow.

The *third form* of chronic Bright's disease, that of waxy kidney, is said to be the consequence of prolonged exhausting disease, such as prolonged suppuration, disease of bone, consumption, and syphilis. The kidney becomes altered in structure, the waxy change beginning, it is said, in the blood-vessels and spreading to the tubules, which become blocked up by a semi-transparent waxy material. As a result the kidney wastes and contracts.

Its **symptoms** are ill-defined, like those of the preceding form. The urine is very copious, pale, and watery, the patient having to rise several times in the night to void it. It contains little albumen at first, but the quantity increases. There is no dropsy. The patient gradually loses strength, but death may not result for several years, even five or ten, and is more commonly due to complications than to the disease itself.

Treatment of chronic Bright's disease. It is impossible to give detailed instructions as to the treatment of chronic forms of this disease. Its complications, affecting stomach and bowels, lungs, heart and blood-vessels, brain and other important organs are so numerous that the treatment appropriate for each case can only be decided by a physician who knows his work and who takes all the circumstances of the case into his consideration. Sometimes a careful scrutiny will reveal causes of the disease whose removal will tend to considerable improvement in the patient's condition, if not to recovery. Thus gout, syphilis, &c., should be treated if present. A general line of treatment can, however, be indicated, that is suited to all forms of the disease. The patient should avoid all exposure to cold and wet. He may be able to select a warm, equable climate, or a sheltered place of residence where he is not liable to sudden great changes of temperature. He should always wear flannels. He should take moderate exercise, and should attend to the condition of the skin, so that by strict cleanliness, and the frequent use of warm baths (taken, of course, with due precautions against cold), the free action of the skin is aided, and undue labour is thus prevented from being thrown on the kidneys. The bowels should never be allowed to become costive. In short, the patient must be surrounded by the healthiest possible conditions of life. The next object of treatment is the maintenance and, as far as possible, the increase of bodily strength. To this end the most nourishing food ought to be made use of, but of the most easily digestible kind. Milk in quantities may be allowed, and nourishing broths and soups, but the quantity of butcher-meat should be restricted. All albuminous food-stuffs (p. 132) throw work on the kidneys, since the result of their breaking down in the body is the production of urea, whose expulsion it is the business of the kidneys to provide for. Limitation of this kind of food, therefore, diminishes the quantity of urea and lessens the work of the kidneys. Chief among the means of strengthening the body is the administration of iron tonics, in the form of quinine and iron wine, or with strychnine as Easton's syrup (of which ½ to 1 tea-spoonful is a dose for an adult), and other similar preparations. *The use of ardent spirits should in all cases be avoided.* This is a general line of treatment, as already said. The treatment of dropsy, which is sometimes relieved by puncturing the dropsical parts, sometimes by free purgatives and by other means, as well as the treatment of other con-

ditions almost certain to arise in the progress of the disorder, is entirely dependent on the circumstances of the patient, of which, it must be repeated, only an educated medical man can form a proper estimate.

Suppuration of the Kidney is an inflammatory disease of the kidney accompanied by the formation of matter. The substance of the kidney is the seat of the disease, in which abscesses may form. It may be caused by inflammation passing upwards from the ureter or bladder, or by the irritation of stone in the kidney, or by a poisoned condition of the blood—pyæmia (p. 236), by injuries, or exposure to cold.

Among its **symptoms** are shivering fits (rigors), pain or uneasiness in the loins, albumen, blood, tube casts and matter in the urine.

Treatment consists in nourishing food and tonics.

Inflammation of the Pelvis of the kidney (p. 289), called by physicians **Pyelitis**, is another form of inflammation which can only be mentioned in such a work as this. It is caused by exposure to cold, stone in the kidney, by obstruction to the outflow of urine causing it to be retained and to become decomposed in the cavity, or by blood-poisoning, and it is marked by attacks of fever, pain in the loins, and changes in the character of the urine, which contains matter in chronic cases. If the obstruction persist owing to the retained materials, the kidney becomes converted into a tumour with fluid contents—decomposing urine and matter. It is difficult of treatment.

Gravel or Stone: Renal Colic: Dropsy of the Kidney.

Gravel or Stone (*Renal calculus,* Latin *ren,* a kidney, *calx,* chalk). The urine contains certain substances in solution, whose natural condition is that of a solid, and which, under certain circumstances, tend to separate out and, assuming the solid form, appear as a sediment in the urine. The chief of these are uric acid, combinations it forms with soda, ammonia, &c., called urates, and phosphates of lime and magnesia. (See p. 302.) Now uric acid may be present in the urine in excess, and as it is not a very soluble body it is readily crystallized out in the form of red particles. Anyone may cause them to be formed in healthy urine by adding a small quantity of strong hydrochloric acid to the urine and setting it aside in a tall glass for a day or two. In time small red particles will be seen forming on the sides of the glass—these, examined by a lens, are found to be crystals of uric acid. Various bodily conditions, connected specially with the digestive system, produce a deposit of uric acid, conditions due to too free living, excess in sugary and nitrogenous foods, and in heavy wines, beer, &c., indolent habits, and affections of the liver that accompany or are aggravated by such habits. Phosphates are held in solution in urine by its acid character, and if the urine becomes alkaline, the phosphates are precipitated. The urine is alkaline in various disorders of nutrition, in nervous dyspepsia, and conditions of general debility; and thus a deposit of phosphates occurs. But after quite healthy urine has been excreted by the kidney, it may undergo decomposition before it is expelled from the body; the result of decomposition is that the urine becomes strongly alkaline, and so again phosphates will be deposited.

Besides these two substances, uric acid and phosphates, there is another, oxalate of lime, which readily separates out from the urine. It should not exist in healthy urine, but appears there as the result of some interference with the due performance of the nutritive processes in the body, it being only a stage in the breaking down of non-nitrogenous food-stuffs.

We see then, that these three substances, uric acid, phosphates, and oxalate of lime, are liable, under certain circumstances, to separate out from the urine as a deposit. They may exist in the urine, however, in a state of such fineness as only to give an unusual cloudiness to the urine, a microscope being required to reveal that the cloud is actually due to solid particles. They may form larger particles capable of being felt or seen, in which case the deposit is termed **gravel**, while again they may form masses of varying size, to which the name of **calculus** or **stone** is given.

Now the deposit may be formed in any part of the urinary organs, from the urinary tubules or pelvis of the kidney to the bladder. A particle deposited in a tubule may be swept on to the pelvis, may be detained there, and grow in size from successive deposits on its surface, may pass to the bladder down the ureter, and being detained there continue to grow. There may, therefore, be stone in the kidney or stone in the bladder, or both. A gritty particle of uric acid swept from a urine tubule may become a stone of size before it is finally got rid of. It may reach the bladder as a uric acid particle,

and there, owing to decomposition taking place in the urine, it may be coated with phosphates, so that it consists of uric acid in the centre and phosphates outside.

Gravel thus differs from stone only in size; and the size of stone may vary from that of a pin's head to that of a goose's egg. The uric acid stones are the most common. They are smooth, hard, and reddish or yellowish brown in colour. Oxalate of lime stones are next in frequency, and form what is called the **mulberry calculus**, because of their appearance, being of a dirty purplish colour, and with a very irregular and rugged surface. Phosphatic stones are also common. They are smooth, light, and earthy in appearance. There are also stones formed of mixtures of these, as already mentioned, and also of other substances which are too rare to be noted here.

One stone may exist or several. They may be present in only one or in both kidneys. No age is exempt from them. They may be present in the kidney of the unborn child.

Symptoms. Gravel may be formed in the kidney and passed in the urine without any symptoms being present. Stone may be formed also without any manifestation, and its presence may be revealed only when it happens to be disturbed and makes an attempt to escape in the water. On the other hand the production and passing of gravel may irritate the kidney and occasion pain in the loins, and frequent desire to make water. The pain often extends downwards towards the groin and bladder, in the direction of the ureter, and is increased by exercise, especially by jolting movements such as riding in a carriage produces. Frequently also there is soreness during the passing of water, particularly at the end of the urethra. The urine is occasionally bloody, the blood not being in streaks, but intimately mixed with the urine. When a stone of any size attempts to pass down the ureter, the pain becomes acute, and is apt to occur in paroxysms, occasioning what is called **renal colic.** It begins suddenly, perhaps rises to intense agony, passes down towards the groin and testicle, which is drawn up (retracted), is accompanied by sickness and vomiting, the patient being bathed in warm perspiration, and frequently produces fainting and collapse. The attack lasts a varying time, sometimes a few hours, sometimes, with periods of relief, for days, and usually ends suddenly, either because the stone has reached the end of the ureter and has dropped into the bladder, or because it has been arrested in its course. The passage of one stone does not imply permanent relief, since others may form, and lead to other attacks.

Treatment depends on the condition giving rise to the production of stone. Uric acid stone is most common, and depends on a highly acid condition of the urine, so that steps taken to diminish its acidity will be useful. Moderation in food and drink must be carefully observed, animal food in excess, highly spiced dishes, and heavy wines being specially avoided. Water, barley-water, milk and water should be used freely to dilute the urine, and alkaline mineral waters, particularly Carlsbad, Friedrichshall, and Hunyadi Janos, to reduce the acidity of the urine. Change of air is also of great value. The administration of acetate or citrate of potash, 40 to 50 grains in a wineglassful and a half of water, three or four times daily, is also highly recommended, to be continued for some months, but suspended for a time if the urine becomes ammoniacal. If oxalate of lime stone is suspected, keeping the urine dilute, by the means mentioned above, avoiding vegetables rich in oxalates, such as rhubarb and sorrel, promoting the action of the skin by exercise and bathing, and the use of the mineral waters already indicated, form the treatment. Since the deposition of phosphates depends on alkaline urine, the result of impaired health, tonic treatment is valuable, and the use of dilute nitro-muriatic acid (10 to 15 drops in water after meals) is urged.

The intense pain caused by the passage of a stone is relieved by hot baths, and hot applications to the loins and side. Opium or morphia in repeated doses is often necessary, but their administration is only safe in the hands of a medical man. Inhalation of chloroform may be necessary in the agony of an attack.

Dropsy of the Kidney (*Hydronephrosis*, Greek *hudōr*, water, and *nephros*, the kidney). This is a chronic disease due to an obstruction to the escape of urine from the kidney. The obstruction is in the ureter and may be in any part of its course, frequently towards the end near the bladder, and often due to a stone arrested in its progress towards the bladder. The result is that the pent-up urine widens the ureter and pelvis of the kidney, leads to wasting of the substance of the kidney by its pressure, so that in the end the kidney may be converted into a sac filled with fluid.

The detection and treatment of the condition it is needless to note here.

Rare Diseases of the Kidney.

Cancer, tubercle, and syphilitic disease may attack the kidney. Hydatid disease, similar to that occurring in the liver (p. 172), also occurs in the kidney.

Movable Kidney is the term applied when the organ is loosely connected to the wall of the belly, to which it is usually firmly bound, so that its position may be altered in various directions. It is more common in women than in men. It may give rise to no symptoms, or may occasion uneasiness and pain of a sickening kind.

Bandages are used to keep the kidney in position, and in particular cases an operation may be undertaken to fix it to the wall of the belly.

UNUSUAL CONDITIONS OF THE URINE AND THEIR DETECTION.

The Examination of the Urine.—A careful examination of the urine is capable of yielding very important indications of the state of health of a person. Sometimes the presence of a disease, quite unsuspected, is revealed by it, and it is a very common thing for physicians, unable because of vague symptoms to decide what is wrong with a person, to have all doubts set at rest by examining the urine. Moreover, such an examination frequently affords the most reliable evidence as to the progress a sufferer is making, whether towards recovery or towards a more serious state of disease. It will, therefore, not be out of place in a work specially intended for the guidance of persons not acquainted with medical science, to give a brief account of the main steps in such an examination. Besides such an account will help to show that the modern practice of medicine rests on a really scientific basis, and is not a mere rule of thumb, hap-hazard procedure. If this were fully realized by the public, the writer is confident it would lead to them taking greater care to place themselves, when the state of their health demanded it, in the hands of educated medical men, and would impress them with the risks they run in seeking the counsels of quacks and impostors.

The **appearance** of the urine should first be regarded. It ought to be quite clear and transparent, depositing after some time a light cloudy precipitate consisting of mucus from the urinary passages. The urine may grow muddy and cloudy when it has become cool, or soon after being passed. A small quantity should be placed in a test-tube or metal-spoon, and *gently* heated over a gas or spirit-lamp flame; if it clears up, the deposit is **urates.** This is due frequently to feverish states, and to disturbance of the digestive system. If the gentle heat makes it more cloudy, a few drops of common vinegar should be added. If it then clears up the deposit has been **phosphates,** and indicates that the urine has been alkaline. It should be noticed that if the urine has stood for some time this may have been due to decomposition in the urine. For urine when passed should be acid, but after standing for some days it undergoes decomposition and becomes alkaline, when phosphates are precipitated, making it muddy. It is only when phosphates appear in freshly passed urine, or in urine quite recently passed, that they are significant. Then they indicate decomposition occurring in the bladder, or an altered condition of blood and nutrition, requiring further investigation.

The nature of deposits other than those mentioned is determined by means of the microscope.

The **colour** of urine varies with the degree of its concentration. That which deposits urates is high-coloured. Other very high-coloured urines should be tested for blood and bile as mentioned further on.

The **quantity** of urine passed in 24 hours is between 2½ and 3 pints. It varies with the quantity of water taken, and with the activity of the skin, being less when the skin is active, as in warm weather, when it is of a darker colour, and greater when the skin is less active, as in cold weather, when it is pale and limpid. Nervous persons pass a large quantity of clear urine of low specific gravity (see Polyuria, p. 302). When a constantly large quantity of urine is passed, it ought to be examined for sugar (see Diabetes, p. 303). Persons ought to distinguish between passing a large quantity of urine and passing it often. Irritability of the bladder will cause frequent desire to pass water, and the person may conclude that an unusually large quantity is voided. This is settled by collecting all that is expelled in 24 hours and measuring it. A constantly small quantity ought to lead to investigation for kidney disease.

The **determination of the specific gravity** of the urine is the next step in a systematic examination of the fluid. This is done usually by means of an instrument, called a **urinometer,** shown in Fig. 142. It consists of a glass bulb of an oval shape, loaded at one end by a small quantity of mercury, and prolonged, at

the other end, into a stem which has a series of marks on it at regular intervals, each mark having a number attached. The instrument is so constructed that if it be immersed in a tall glass containing distilled water, it will sink in the water for a certain distance and then float with the stem upright. The water will reach to the top score on the stem, marked 0. Now if 10 ounces of common salt be dissolved in 1000 ounces by weight of distilled water, and if the tall glass be nearly filled with this solution, and the urinometer placed in it, it will sink till the stem is immersed up to the mark 10, indicating that there are 10 parts of solid matter in every 1000 parts of the fluid. Suppose now the tall glass be nearly filled with urine, and the urinometer be placed in it, the level to which the stem is immersed in the urine can be read off, and thus the quantity of solid matters ascertained. If the urinometer floats at the mark 20, that means that in every 1000 parts of such urine there are 20 parts of solid matters dissolved, and so on. The specific gravity of urine is usually about 1020. But it varies with circumstances. Thus if the skin be very active or the weather hot a large quantity of water will escape by the perspiration, the quantity of water expelled by the kidney will be less, and the urine will contain a greater quantity of solids in proportion to its liquid parts. Again, if a large quantity of water or other dilute fluids be drunk, more water will escape from the kidneys and the urine will be more dilute. In order not to be misled by temporary variations one ought to collect all the urine passed in 24 hours, mix it, and take a sample of the mixture.

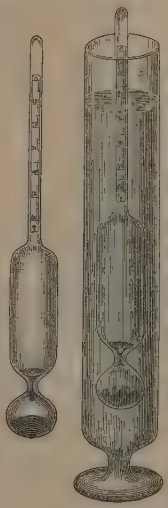


Fig. 142.—Urinometer.

A low specific gravity, 1015 or thereby, should lead to testing for albumen, not because the presence of albumen lowers the specific gravity, but because in albuminuria there is frequently a diminished quantity of the usual solids of the urine. A high specific gravity, 1030, 1035, &c., almost surely indicates diabetes.

The **acidity** or **alkalinity** of the urine is determined by the use of blue litmus paper, which remains blue if dipped into an alkaline fluid, but is changed to red if the fluid be acid. As already stated healthy urine is feebly acid when passed. After a little it becomes more acid, and then with decomposition it becomes alkaline. Urine may be affected in this direction by food and drugs, a diet rich in animal food rendering it highly acid, and one rich in vegetable diet or alkaline drugs (soda, potash, &c.) tending to make it alkaline. If there is no reason in the food for one condition or the other, further examination is necessary, lest the high degree of acidity indicate excess of uric acid in the system, as in gout or in the condition tending to the formation of uric acid stone, or lest, on the other hand, some affection of the bladder be causing premature decomposition of the urine and its consequent alkalinity, or lest some other serious condition of body be present.

The **detection of albumen** in the urine is of great importance. A small quantity of urine is heated to boiling in a test-tube over a gas or spirit-lamp flame, a few drops of acetic acid being added. If albumen be present in any quantity a white flaky precipitate appears, the thickened albumen. Any one can imitate this test by mixing a small quantity of white of egg with water, placing it in a test-tube and boiling. In extreme cases the urine may become almost solid. A simple way of performing the test is to take some urine in a metal spoon, add a few drops of vinegar and heat to boiling. If albumen be present in very small quantity this test is not delicate enough. A more satisfactory one is afforded by pouring the urine into a test-tube to the depth of from 1 to 2 inches, inclining the test-tube to one side and pouring down the side gently, and drop by drop, strong nitric acid, to the extent of half the quantity of urine. Then gently raise the test-tube to the upright position, taking care not to shake the fluid. The nitric acid and urine will be found to form two layers distinct from one another, the heavy nitric acid at the bottom of the tube and the urine above it. If albumen be present a white cloud appears at *the junction of the two fluids*. The success of the test largely depends on the two fluids being kept from mixing.

To detect bile take a small quantity of urine in a test-tube, drop in a small morsel of lump-sugar, incline the test-tube and slowly pour down the side a quantity of strong sulphuric acid (oil of vitriol) equal to that of urine. The acid forms a colourless layer at the bottom, urine is above it, and the piece of sugar is between the two. Raise the test-tube and watch

the junction between the two layers, the fluids being kept from mixing by shaking being prevented. The appearance of a deep purple colour indicates the presence of bile. A dark brown colour of burnt sugar, caused by the action of the acid on the sugar, must not be mistaken for the purple. Bile is present in the urine in jaundice and diseases of the liver, to which refer (pages 195 to 199). Another method consists in pouring some urine on a white porcelain plate and pouring beside it some drops of *fuming* nitric acid (nitric acid containing nitrous acid). At the junction of the fluids there appears a play of colours, beginning with green and going on to blue, violet, red, and ending in yellow. Both these tests give satisfactory results only in experienced hands.

To **detect sugar** in urine there are various tests. Fill a test-tube to one-third with urine, add an equal quantity of liquor potassæ, and boil the top of the mixture, by causing the flame of a spirit-lamp to play on the side of the tube. The appearance of a sherry-brown colour, deepening on continued boiling, indicates the presence of sugar. Another test consists in adding a drop or two of solution of sulphate of copper to urine in a test-tube, then enough liquor potassæ to give a clear dark blue solution, then boiling the surface of the mixture. If sugar be present a red or orange coloured precipitate appears. The presence of sugar indicates diabetes.

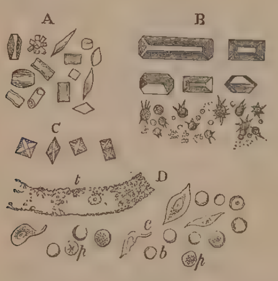


Fig. 143.—The Microscopical Appearance of certain Deposits of Unhealthy Urine.

A, Various crystals of uric acid, found in acid urine. B, The larger crystals are phosphates. These are found in alkaline urine. The small spiked balls, &c., are urates of ammonia. C, Crystals of oxalate of lime (see p 299). D, Organized deposits; *t*, tube cast; *b*, blood cells; *c*, cells of the kidney or bladder, *p*, pus cells (matter).

By examination with the microscope the presence of blood (see **Hæmaturia**, p. 304), matter, crystals of uric acid or oxalate of lime (see p. 299), cells from the kidneys or urinary passages, casts of the tubules of the kidney, produced by material capable of clotting, being poured into the tubes as a result of inflammation (see BRIGHT'S DISEASE), and other unusual constituents may be detected. The urine is allowed to stand for some time in a conical glass. A glass tube drawn to a fine point is passed down to the bottom and a few drops of the fluid are withdrawn. A drop is placed on the centre of a glass slide, used for microscopical purposes, and covered with a cover-glass. The slide is placed on the stage of a microscope and examined with a lens magnifying by 300 diameters. The forms of these various bodies are exhibited in Fig. 143.

Albuminuria is the condition in which albumen is found to exist in the urine. It is a symptom of disorder of the kidneys. (See CONGESTION OF THE KIDNEYS and BRIGHT'S DISEASE, pp. 294, 295.) The tests for albumen in the urine have been mentioned on the preceding page.

Polyuria (*Diabetes Insipidus*) is a disease characterized by the passage of large quantities of urine, of low specific gravity (1001 to 1010), and without the presence of albumen or other unhealthy constituent.

It is a curious and rare disorder, its cause being not understood. It is hereditary and has been known to be transmitted through four generations, and is related to true diabetes, in which sugar is present in the urine. It may occur at any age and to either sex. It may exist in the newly-born child, and is rather more common in early than in later life. It is supposed to be connected with tuberculosis (Sect. XIV.), disease of the brain, and intemperance. Its supposed connection with nervous disease is strengthened by the fact that the famous French physiologist, Claude Bernard, who found that a puncture in the floor of the fourth ventricle of the brain (p. 91) at a particular spot occasioned true diabetes, found also that a puncture in a slightly different situation produced polyuria.

Its chief **symptom** is the excretion of large quantities of urine, even larger quantities than in true diabetes. The urine is of low specific gravity and contains no albumen or sugar. Pailfuls of urine may be passed daily, and the person is tormented by constant desire to drink and to pass water. Thirst is present, and occasionally the appetite is great. A patient of the French physician, Trousseau, was paid by some restaurant keepers not to dine there, since the quantity of bread (supplied without extra charge) he consumed was enormous. Some suffering from this disease can drink large quantities of

intoxicating liquors without being in any way affected thereby. In many cases no other symptoms accompany the disease, and the patient may live to a good age. In other cases impaired health follows, though death is usually owing to some other affection.

No **treatment** of special value is known. The diet should be regulated, and tonics (quinine, iron, and strychnine tonic—see PRESCRIPTIONS) administered. Water should not be withheld. Ergotine, in doses of 2 grains twice or thrice daily, and continued for some time with occasional intervals, might prove of benefit.

Diabetes Mellitus (from Greek *dia*, through, and *baino*, I flow, and *melitta*, a bee; *Glycosuria —sugar in the urine*) is a disease of which the chief symptom is the presence of sugar in the urine.

Its **cause** is not known. Claude Bernard found that it might be artificially produced in animals by puncturing the floor of the fourth ventricle of the brain. It is sometimes hereditary and may be present at any age and in both sexes, being most common in adults from 25 to 60 years of age.

The **symptoms** are the passing of a constantly excessive quantity of urine, which gradually becomes more and more abundant, thirst, excessive appetite, dry harsh skin, and gradual loss of flesh and strength. These symptoms usually increase slowly. The urine is pale in colour, with a peculiar sweetish heavy smell; from 8 to 20 or 30 pints may be passed daily; it is of high specific gravity (1030 to 1040); and the presence of sugar is sometimes indicated by the patient noticing that it is attractive to flies, bees, &c. It rapidly ferments if kept in a warm place. The presence of sugar is determined by the tests mentioned on p. 302. The large quantity passed causes frequent calls to pass water. The thirst cannot be satisfied, and is accompanied by a parched and clammy condition of mouth and throat. Appetite is often voracious, though in the later stages it may be lost. The tongue is red and irritable, the gums inflamed and the teeth liable to decay. Costiveness is common. The body is wasted, the strength reduced, and languor and weariness produce disinclination to exertion. The harshness of the skin is marked, there is tendency to boils, and wounds do not readily heal. Failure of sight from the formation of cataract is frequent. While these are the symptoms of a marked case, sugar may exist in the urine without any prominent symptom leading to its detection. Specially is this liable to be the case when the disease begins in persons advanced in life. In two cases, under treatment by the writer, an intolerable itching about the genital organs led to an examination of the urine and the detection of diabetes, of which no other marked symptom was present. Stout people advanced in life may thus be affected without losing their stoutness, in whom dyspepsia and general weakness are the chief complaints. In such patients recovery is much more probable than in the fully evident disease, and the complaint is in no way so distressing. The disease is essentially a chronic one, though death occurs, in some cases, with great rapidity. The younger the patient the more grave is the disorder. From six months to three or four years is the duration of the disease, and it terminates by exhaustion or by other induced diseases. Consumption is liable to attack and carry off a diabetic person. Death sometimes occurs by coma (unconsciousness), and then it may be sudden.

Treatment.—The chief treatment consists in regulation of the diet. All articles containing sugar or starch (which is converted into sugar in the body) should be rigidly excluded. To show what substances may be eaten, because of absence of sugar or starch, and what may be drunk, as well as what ought to be avoided, because of the sugar or starch they contain, the following tables from Pavy are given:—

THE DIABETIC PATIENT MAY EAT

Butcher's meat of all kinds, except liver.
Ham, bacon, or other smoked, salted, dried, or cured meats.
Poultry. Game.
Shell-fish and fish of all kinds, fresh, salted, or cured.
Animal soups not thickened, beef-tea, and broths.
The almond, bran, or gluten substitute for ordinary bread.
Eggs dressed in any way.
Cheese. Cream cheese.
Butter. Cream.
Greens. Spinach. Turnip tops. *Turnips.
*French beans. *Brussels sprouts.
*Cauliflower. *Broccoli. *Cabbage.
*Asparagus. *Sea-kale. *Vegetable marrow.
Mushrooms.
Water-cress. Mustard and cress. Cucumber. Lettuce.
Endive. Radishes. Celery.
Vinegar. Oil. Pickles.
Jelly, flavoured but not sweetened.
Savoury jelly.
Blanc-mange made with cream but not milk.
Custard made without sugar.
Nuts of any description except chestnuts. Olives.

**Those marked with an asterisk may only be eaten in moderate quantity, and should be boiled in a large quantity of water.*

Must Avoid Eating

Sugar in any form.
Wheaten bread and ordinary biscuits of all kinds.
Rice. Arrowroot. Sago. Tapioca. Macaroni. Vermicelli.
Potatoes. Carrots. Parsneps. Beet-root.
Peas. Spanish onions.
Pastry and puddings of all kinds.
Fruits of all kinds, fresh and preserved.

The Diabetic Patient May Drink

Tea.* Coffee.* Cocoa from nibs.*
Dry sherry. Claret. Dry Sauterne. Burgundy. Chablis. Hock.
Brandy and spirits that have not been sweetened.
Soda-water.
Burton bitter ale, in moderate quantity.

Must Avoid Drinking

Milk, except sparingly.
Sweet ales, mild and old. Porter and stout. Cider.
Lemonade. Ginger-beer, &c.
All sweet wines. Sparkling wines. Port wine. Liqueurs.

Thus the patient must deny himself sugar in every form, and he must leave ordinary bread, biscuits, potatoes, and sweet vegetables out of his diet. This may be done gradually by dropping potatoes and taking only a small half-slice of bread well toasted, or bran bread well toasted. Special bread is made for the diabetic called gluten bread, made of flour out of which all the starch has been washed. It is unhappily not very palatable, and patients soon tire of it. Almond cakes may be used. For drinking, soda-water, or soda-water and cream is refreshing.

The patient should take regular moderate exercise, flannels should be worn, and warm baths frequently taken.

Many medicines have been tried, but none are very successful. Opium and ergot are probably the best, and may be taken in pill, containing ½ grain powdered opium and 2 grains ergotine, one thrice daily. In many cases the use of opium ought to be pushed, but not without medical supervision.

It should not be forgotten that the regulation of the diet is the chief treatment, and that a return to ordinary diet, because of the irksomeness of a restricted one, is almost certain to restore the worst symptoms. Efforts should be made, by constantly varying the kinds of food used, of those recommended in the first list, to diminish as much as possible the feeling of loss, because of the want of customary things.

* *With cream but without sugar.*

Blood in the Urine (*Hæmaturia and Hæmatinuria*). Blood may exist in the urine under a variety of circumstances. It may come from the kidney, from the ureter, from the bladder, or other parts of the urinary tract. If it come from the kidney it is more likely to be uniformly mixed with the urine, which has in consequence a smoky colour, than when it comes from the bladder, when it is more likely to present the appearances of ordinary blood and to be less mixed with the urine. It may be passed in clots. Congestion of the kidney, or inflammation of various kinds, or the presence of stone may be among its causes, while growths or stone in the bladder commonly produce it. When it is in small quantity the smoky colour of the urine suggests its presence, and this may be most easily verified by discovering blood corpuscles in a drop of the urine examined by a microscope.

Paroxysmal hæmatinuria is the term applied to a curious affection, due to exposure to cold, in which the patient, after complaining of uneasiness across the loins and chilliness, becomes extremely cold, is pale, has an attack of shivering, shortly afterwards passes urine resembling porter, very dark coloured and muddy, because of the presence of blood. Sometimes sickness and aching in the limbs attend the attack, which soon passes off, but is liable to occur again suddenly after varying intervals. Sometimes the attacks occur after regular intervals. The poison of ague has been said to have a part in the tendency to the disease.

Treatment for bloody urine depends on its cause. When it is coming in any quantity the person should be kept quiet in bed. Cold compresses may be applied over the loins if it is supposed to come from the kidneys, or over the lower part of the belly if it is supposed to come from the bladder. If the discharge is profuse, 5-grain doses of gallic or tannic acid may be administered by the mouth every four or six hours while necessary. During the paroxysmal attacks the patient should be kept warm in bed. The prevention of the attacks is more easily accomplished than the treatment. Exposure to cold and wet should be avoided; the person should be clothed in flannel; and quinine and iron tonics should be taken.

In both kinds of cases, however, the determination of the causes of the disturbance is so difficult, and their recognition of so much importance, that no delay should be made in consulting a physician.

Chylous Urine (*Chyluria*) is a condition in which the urine is milky from the presence of chyle or lymph (p. 200) and clots, like size, on standing. It is a disease of tropical climates. In many cases the disease has been associated with a worm, the *Filaria sanguinis hominis*, occurring in the blood.

Suppression of Urine is the term applied when no urine is passed from the kidneys. It is to be distinguished from retention of urine (p. 306), in which the kidneys form urine which accumulates in the bladder. It is a very serious condition, occurring in the course of cholera, certain infectious diseases, and inflammations of the kidneys, and if continued leads to uræmic poisoning (p. 296). In cases of hysteria suppression of urine may last for some time without any symptoms of uræmia.

DISEASES OF THE BLADDER.

Inflammation of the Bladder (*Cystitis*) is of the nature of catarrh (p. 154), in which the lining membrane of the bladder becomes congested and swollen and pours out mucus. Breaches in the mucous membrane may occur leading to ulceration, blood may escape from congested vessels, and abscesses in the walls may be produced. Irritation of the bladder from the presence of stone, or from the retention of urine, occasions it. The irritation is sometimes due to substances in the blood. Thus poisoning by cantharides, the material of which fly blisters are made, occasions a very painful inflammation; and this may result from absorption from a fly blister placed on some part of the body. Extension of inflammation, such as that of gonorrhœa, excessive drinking, and exposure to cold, are other causes. The disease may be acute or chronic.

The **symptoms** are frequent passing of water, or constant desire to pass it, not much being expelled at a time, the act being accompanied by tenderness or burning pain. There is also tenderness or pain over the region of the bladder in the lower part of the belly, or in the groins, and in the region of the fundament. Fever is present. The urine is cloudy with mucus, or contains it in quantity, and blood may be mingled with it. In chronic forms the symptoms are less marked, but the urine is more altered and may be offensive to the smell.

Treatment.—Hot fomentations should be applied to the lower part of the belly or between the legs. Warm baths are useful. The bowels should be freely opened by a dose of calomel followed by castor-oil, or by a warm injection. If the pain is severe, 10 to 15 drops of laudanum may be given, at intervals of 2 or 3 hours, to be stopped when the pain is relieved. Plenty of watery drinks should be allowed, barley water, linseed tea, &c. The patient should be kept at rest, and only mild diet without stimulants allowed. Should the inflammation be due to the presence of stone or other irritant its removal is, first of all, necessary. In chronic cases it is important that the bladder be thoroughly emptied, and for this purpose the use of the catheter (see MEDICAL AND SURGICAL APPLIANCES) is often necessary. Baths or hot fomentations are useful for relieving pain. The medicines mostly used are infusion of the leaves of buchu, of red bearberry (*uva ursi*), of pareira brava, or of the root of dog's-grass (*triticum repens*). These infusions are made as one makes tea, one or two ounces of the leaves or root being used to one pint of boiling water. The dose is one to four ounces of the liquid three times daily. The freshly-prepared infusion is best; but fluid extracts may be obtained from chemists, of which one tea-spoonful in water is a dose.

Irritability of the bladder is indicated by frequent desire to pass water, the frequency not being due to an excessive quantity of water requiring to be voided. It is often due to excessive acidity of the urine, to irritation in the bowels, such as piles may induce, or in neighbouring organs, in women to irritation of the womb, in children to the irritation of worms. The irritation may be in the prostate gland at the neck of the bladder. Mere nervousness may occasion it.

Treatment.—The cause of any irritation should be sought for and removed, if possible. Excessively acid urine may be corrected by alkaline remedies such as citrate of potash (20 grains in water), excessively alkaline urine by 10 drops dilute hydrochloric acid in water, the doses being repeated several times daily as required. Belladonna ($\frac{1}{4}$ grain of the extract in pill) is useful, specially in nervous cases. If the person is in weak health quinine and iron tonics are called for. Plain diet is necessary, and all excesses should be avoided. Regularity of the bowels is of great consequence.

Paralysis of the bladder may be the result of injury or disease of the spine, or of parts in the neighbourhood of the bladder. Over-dis-

tention of the bladder often leads to inability to empty it properly. As a result either the urine is retained in the bladder or it constantly dribbles away. In such cases the catheter must be passed (see MEDICAL AND SURGICAL APPLIANCES).

Retention and Incontinence of urine.—In *retention* the bladder is constantly full and the patient cannot empty it. It is, however, commonly accompanied by constant dribbling of urine, so that the person thinks his bladder cannot hold the urine. He imagines his bladder is empty, whereas it is simply the overflow, the quantity that cannot find accommodation in the already over-distended bladder, that escapes. True *incontinence* is present when the bladder can retain no urine, and such cases are rare, occurring only in paralysis. As a rule in so-called incontinence, affecting usually men advanced in years, the bladder is over-full, being unable to empty itself, and only the overflow dribbles away. In the lower part of the belly the distended bladder may be felt as a tumour, and uneasiness is experienced there.

The **treatment** consists in passing the catheter and withdrawing the urine; and this requires to be done regularly till the bladder recovers its tone. Retention sometimes occurs suddenly—for example, to men on a journey who cannot get an opportunity to empty the bladder, and who, when the opportunity occurs, find they cannot then make water in spite of effort. Sometimes in such cases a hot hip-bath relieves.

Incontinence of urine in children is spoken of in the section devoted to DISEASES OF CHILDREN.

Stone in the bladder.—The causes of the formation of stone have been considered at p. 298.

Its **symptoms** are irritability of the bladder, frequent desire to pass water, and symptoms of chronic inflammation. There is pain occasionally at the neck of the bladder or point of the penis, aggravated by jolting exercise. The stream of urine is sometimes suddenly arrested by the stone falling over the opening from the bladder, and on the person changing his position it flows again. Blood frequently occurs in the urine. Stone cannot, however, be absolutely said to be present till a surgeon has detected it with a sounding instrument.

Treatment consists in crushing the stone by means of an instrument passed up the passage into the bladder, and allowing the fragments to be washed away in the urine. Such an operation is called lithotrity. The stone may be removed entire by means of an opening made into the bladder, through which the stone is drawn by forceps. This operation is called "cutting for stone" or lithotomy. Relief from some of the symptoms may be had by such measures as are recommended for inflammation of the bladder (p. 305).

Tumours of various kinds, cancerous and others, may occur in the bladder, and lead to symptoms of chronic inflammation, sometimes to serious loss of blood.

SECTION XI.—THE SKIN, HAIR, AND NAILS.

A.—THEIR ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

The Skin:
- *Its structure*—Dermis and Epidermis;
- *Sweat glands;*
- *Hair and Nail;*
- *Glands* (Sebaceous) *of the hair;*
- *Functions of the Skin*—protection—excretion—the nature of sweat—regulation of temperature—absorption.

The skin occupies an important position as an organ of the body. It is a blood-purifying organ in as true a sense as the lungs or kidneys are, while it also performs other very important duties. It is not, therefore, merely a protective organ as is too generally supposed. It does form an external covering for the deeper tissues over the whole body, and that its protection is very necessary and efficient everyone knows who has experienced the pain produced by the contact of almost anything with a part of the body from which the top skin has been removed; but in some respects this is the least valuable, though the most apparent, of the functions it discharges.

Its structure is remarkably complex. The

skin consists of a deep layer called the **dermis**, **corium**, or **true skin** (*cutis vera*), and of a superficial layer—the **epidermis** (Greek *epi*, upon, and *derma*, the skin), **cuticle**, or **scarf skin** (*a*, Fig. 144). The true skin consists of fibrous tissue, the bundles of which form a felted interlacement. It lies upon a bed of fatty tissue (*c′ d*, Fig. 144) which fills up the inequalities of the surface on which the skin rests. Groups of the fat cells of this tissue also abound in the deepest layers of the true skin. Pervading the fibrous tissue is also an abundance of fibres of the elastic sort (p. 16) which confer elasticity on the skin. The true skin (*b–e*) is very vascular, that is, is richly supplied with blood-vessels, so that when cut it bleeds; and nerve fibres are likewise disposed in it, conferring sensibility. The surface of the true skin is thrown into a series of elevations, papillæ, or finger-like prominences (*b*, Fig. 144) which are specially rich in capillary blood-vessels and nerve endings, and which are thus particularly vascular and sensitive. Above the true skin is the scarf skin, the projections of the former fitting into excavations in the latter. The epidermis, however, is composed entirely of cells, and is quite devoid of blood-vessels or nerves, so that it may be cut without bleeding or pain. There are several layers of cells, and the shape of the cells alters from the deep parts upwards. The cells directly lining the surface of the true skin and the papillæ are columnar and nucleated. They are soft and active cells, and clothing the papillæ are several layers of them. In the layers nearer the surface the cells lose their columnar shape and become more flattened. They also gradually become less soft and more horny, until towards the surface they are flattened and scale-like. The surface scales are continually being thrown or rubbed off, and their places are supplied by deeper cells which reach the surface by growth from below. New cells are continually being produced in the deep layer in contact with the true skin; and as they are formed they push upwards the already existing cells. So that cells originally active and columnar

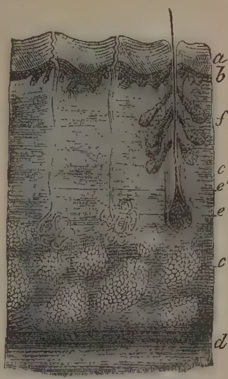


Fig. 144.—The Structure of the Skin.

gradually pass upwards, becoming horny, till they are finally cast off. The fine white dust that one may scrape off the skin consists of these horny scales.

It is in the deep and active layers, called the **rete mucosum**, of the epidermis that colouring matters are present, which give the hue to the skin. For example, in dark races black pigment is present in these cells. The epidermis is thickest over the parts exposed to greatest pressure or friction, securing protection to the sensitive true skin below.

At the openings of the body the skin passes into mucous membrane, the structure of the two being practically identical, the differences being merely in the thinness of the epidermal covering of the mucous membrane and the increased supply of blood to the membrane.

Glands of the Skin.—The special glands of the skin are the **sudoriparous** (*e*, Fig. 144) or **sweat glands** (Latin *sudor*, sweat, and *pario*, to bring forth). They are tubular glands. Deep in the substance of the true skin, or in the fatty tissue beneath it, the tube is coiled up into a sort of ball. From the coil the tube passes upwards through the true skin, following a wavy course, till it reaches the epidermis, which it penetrates in a spiral manner till it opens on the surface. Two of such glands are shown in Fig. 144 (*e e′*). The tubes consist of delicate membranous walls lined within by cells. The coiled part of the gland is surrounded by a dense network of fine blood-vessels, and thus the cells of the gland are separated from the blood by only a very fine membranous partition, and can draw from it what supplies they need for their particular work.

It is estimated that the total number of sweat glands in the human skin is over two millions. They are not, however, equally distributed over the body. They are fewest in the back and neck, where it is estimated there are on an average 400 to the square inch. They are in greatest number in the skin of the palm of the hand, where they amount to nearly 3000 in each square inch, according to Erasmus Wilson, 3528. Their openings occur on the ridges into which the skin is there thrown, and may be made out by a hand lens. Next to the palm of the hand they occur in greatest number in the sole of the foot, next on the back of the hand and foot, and the smallest number is that already noted in the skin of the back. The length of a tube, when fully straightened out, is about $\frac{1}{4}$ inch; so that, according to Sir E. Wilson, in

one square inch of skin from the palm of the hand there is a length of sweat tube equal to 73½ feet. Estimating the number of glands in the body to be between two and three millions, the total length of tube devoted to the secretion of sweat would be about *10 miles.* According to Erasmus Wilson's estimate it amounts to even *28 miles.*

Hair.—Hairs and nails are originally derived from the epidermis, and are essentially cellular structures. A hair is formed by a folding or dipping inwards of the skin. A depression or furrow is thus formed, the inner walls of the depression consisting of the infolded epidermis. The depression takes the shape of a sac and is called the **hair sac or hair follicle.** At the bottom of the follicle is an enlarged papilla of the true skin (*c*, Fig. 145) pushed downwards by the folding-in process. Like the

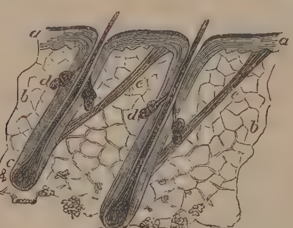


Fig. 145.—Hair, Hair Follicles and Glands.
a, epidermis; *b*, true skin; *c*, hair bulb; *d*, sebaceous glands; *e*, muscle and hair sac.

other papillæ of the skin it is covered with the active cells of the deep layer of the epidermis, which form a bulbous enlargement over the papilla, that is, the root of the hair. As the cells in direct contact with the papilla grow and multiply those above them are pushed upwards to make room for them, and owing to the shape of the hair sac the cells become packed together so as to form a cylinder or stem, which finally, as the growth from below goes on, is pushed out beyond the skin as the shaft of the hair. A hair thus consists of a peculiar arrangement of the cells covering the true skin. So closely are the cells packed to form the cylinder that a fibrous appearance is presented, except in the centre of the hair—the medulla—where the cells still retain their shape, and make the hair appear different in the centre from the circumference. The hair is thus *not a tube but a solid rod* composed of cells packed tightly at the circumference and loosely in the centre. Sometimes little spaces exist in the centre owing to absorption of cells, and the spaces are filled with air, giving in some parts the appearance of a tube, when the hair is examined under the microscope. The different colour of hair is due to pigment present in the cementing substance between the cells as well as in the cells themselves.

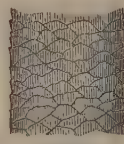


Fig. 146.

Fig. 146 shows the appearance under the microscope of a hair, the cells overlapping one another like tiles on a roof.

Glands of Hair.—Opening off from each hair sac are one or two glands (*f*, Fig. 144), the **sebaceous** glands (Latin *sebum,* tallow). They are also shown in Fig. 145, *d*, and consist of groups of minute sacs lined with cells, which produce an oily material to lubricate the hair and skin. Connected with each hair sac, especially if of a good size, is a bundle of involuntary muscular fibres (*e*, Fig. 145). The bundle passes in such a direction that, when it contracts, the hair sac, which is placed obliquely in the skin, is caused to become more upright, and thus the hair is made "to stand on end." It is this that causes the appearance of "goose's skin."

A **Nail** is also a compact mass of epidermal cells. At the bottom of a fold on the skin is the root of the nail, at which growth takes place by multiplication of cells. The nail is thus continually pushed forward by the growth behind. The bed on which the nail rests, and from which it also receives additions, is formed by numerous papillæ of the true skin.

Just as in man hair and nails are altered epidermal structures, so the feathers of birds, and the claws of animals, are formed from the surface layers of the skin.

Functions of the skin. Manifestly the skin *covers in and protects* the more delicate structures that lie beneath it. This it does by means of the horny and insensitive epidermis; for everyone knows that if an injury tears off the cuticle the uncovered true skin is keenly sensitive to the slightest contact with any foreign body, and to heat and cold. The epidermis also protects from the absorption of poisons, for one may handle with impunity, when the skin is whole, substances which, gaining access by the smallest wound, might cause serious injury. The skin, however, ranks as *an excretory organ* of importance. Its excretion is called sweat, and is the product of the sudoriparous glands. In addition the sebaceous glands secrete an oily fluid useful for lubrication.

The sweat or perspiration is a colourless transparent fluid, consisting chiefly of water, but containing a small quantity of saline material and traces of urea, and being of acid reaction. In some parts of the body, and especially in the arm-pits, the glands secrete a substance having a peculiar smell. It would seem also that some carbonic acid gas passes off by the skin, but not more than $\frac{1}{50}$th of what escapes by the lungs. In ordinary circumstances the sweat passes off from the skin as vapour as fast as it reaches the surface. One would readily conclude, therefore, that usually the skin is not active. This is not so. On an average the quantity of water that escapes from the skin as vapour is about 2 lbs. daily. If strong exercise be engaged in, or if the body be exposed to great external warmth, particularly when the external air is moist, the sweat becomes more abundant, and, unable to pass off quickly enough, collects on the surface in drops. A distinction is, therefore, drawn between **insensible perspiration**, the perspiration that passes from the skin unseen as vapour, and **sensible perspiration**, the sweat that collects on the surface. The distinction is worth noticing, since water is continually being lost from the surface of the body, though at times it is quite apparent, and at other times not so. A man's weight may be reduced several pounds in an hour by loss through perspiration alone. To some extent this may explain the weakening effect produced by excessive sweating in the course of some diseases, for example the night-sweats of consumption.

It is in the coiled part of the sudoriparous gland that the sweat is produced. The blood that surrounds the coil in capillary vessels is in intimate connection with the cells of the gland, and it is from the blood that the cells separate the materials that form the perspiration. It is thus apparent that the greater the quantity of blood flowing to the skin the more sweat is likely to be formed. The blood-vessels of the skin, like the blood-vessels of other parts of the body, are under the control of the nervous system, by which their width is regulated. If the nervous control is removed the blood-vessels widen, more blood flows through them, and more raw material is brought to the glands. In other ways the blood-vessels may become more fully charged with blood than usual. External warmth relaxes the skin and the vessels; there is thus a determination of blood to the skin and increased perspiration. On the other hand external cold causes the skin and vessels to contract, diminishes the supply of blood, and lessens the amount of sweat. By such a process as this the skin is able to discharge a third function, that of **regulating the temperature of the body**.

The transition of a liquid to the state of vapour is always accompanied by a loss of heat. Heat is necessary, that is to say, to convert a liquid into a vapour. Any liquid that very quickly evaporates produces, when placed on the skin, a marked sense of coldness, because the heat necessary to transform the liquid into vapour has been drawn from the skin, and withdrawn quickly. Even so, every particle of sweat that reaches the mouth of a sweat gland and passes off into the air carries with it a certain quantity of heat from the body, and cools the body by that amount. It is this that makes one so readily feel chilly after excessive sweating, the evaporation of a large quantity of sweat rapidly cooling the surface. Now, if the atmosphere be very warm, a greater quantity of sweat will be produced, as we have seen, and its evaporation will tend to prevent the heat of the body rising. Whereas, if the atmosphere is cold, much less sweat is produced, and the loss of heat from the body is greatly lessened, and its temperature prevented from falling. Thus the skin greatly aids in maintaining an average heat of the body, and in preventing rises and falls of its temperature with every variation of the external atmosphere.

It would seem also as if the nervous system had some direct action on the sweat glands. Fear or other strong emotion often causes sweat to break over the skin even while the surface is very pale and the quantity of blood diminished. Cold sweats are frequent in the extreme depression that precedes some forms of sickness or fainting. It is probable that such outbursts of sweat are due to some nervous influence accompanying the general condition and acting directly on the sweat glands.

Many drugs influence the process of sweating either by increasing the amount or by diminishing it. Thus opium causes profuse sweating, while atropine, the active principle of belladonna, is capable of completely arresting it.

The reason for giving medicines to excite sweating during the course of some fevers is plain. By promoting the activity of the skin they tend to reduce the heat, and, moreover, by increasing the quantity of material separated from the blood they widen a channel by which unhealthy stuff that may exist in the blood and be the cause of the disturbance may be swept out.

Some relationship exists between the skin

and kidneys. In cold weather, when the skin is less active, a large quantity of water is passed off by the kidneys, while in warm weather, or under circumstances producing great activity of the skin, the quantity of water separated by the kidneys is proportionately diminished. This is a point of great importance. It indicates that, when disease of the kidneys is present, these organs may be relieved to a considerable extent and their labour lessened by any means which excite perspiration.

If the skin be covered over by varnish, so that its functions are completely arrested, death speedily results. The reason is not known, though many explanations of the circumstance have been offered. After varnishing the bodily heat falls very rapidly, due, it has been said, to the blood-vessels of the skin becoming very wide, permitting a large flow of blood to the surface and rapid cooling in consequence. In animals that have been varnished death has been delayed for a considerable time by wrapping them in cotton wool, and thus hindering the great loss of heat, or by placing them in some warm place to maintain the temperature. This, however, does not seem to explain all the effects of varnishing the skin. Symptoms of blood poisoning arise, and albumen appears in the urine, in fact symptoms similar to those of uræmic poisoning, which is described on p. 296. The retention of poisonous matters in the blood, owing to the activity of the skin being set aside, would explain such symptoms. Some confirmation of this view is afforded by the statement of a German observer that the injection of filtered sweat caused fever and albumen in the urine.

Tarring and feathering, the punishment of mob-law in some parts of America, have effects similar to those of varnishing the skin, and cause a painful death after some time. The hot tar, poured over the body, so enters and closes up the pores of the skin, that it is practically an impossibility to remove it. The effort to wash off the tar by scrubbing, &c., is attended by extreme pain, because the fine hairs all over the body become so embedded in the tar that they are pulled out in the process. Probably the best method to remove it would be to seat the person in a bath of turpentine, if such could be obtained, and to rub only with the hands. If, in such a case, patches of the skin could be cleaned here and there, so that their activity could be restored, these patches would sufficiently discharge the functions of the skin to avert a fatal result. For this purpose turpentine or benzine would be the best agent to employ.

Finally, the skin seems capable of absorbing matters to which it is freely exposed, and of passing them onwards into the blood. Fluids in contact with the skin, and solid substances rubbed into it, may be absorbed. Thus cases are on record where persons have gained weight by exposure to a moist atmosphere, or by immersion in a bath. Sailors, deprived of fresh water, have been able to allay their thirst by wearing their clothes soaked in salt water. Mercury and other ointments rubbed into the skin are capable of acting on the system, apparently because particles gain entrance to the lymphatics. The extent to which absorption occurs through the sound skin, however, is not great. Even where vigorous rubbing is performed to force the particles into the mouths of the glands the absorption is limited. But from parts where the scarf-skin has been removed, various substances may be picked up and passed rapidly into the blood. Sometimes, therefore, where it is thought desirable to act through the skin, a small blister is applied, and the substance—morphia powder, for example—dusted over the raw surface.

The part played by the skin in touch will be considered in the section on the organs of sense (p. 335).

These considerations as to the functions of the skin ought to render it apparent that the skin is a very important organ of the body. It is not, however, generally viewed in this light. At least it very often does not receive the care and attention which, as such, it deserves. It will be apparent that the minute openings of the sweat glands—the pores of the skin as they are called—may be easily blocked by worn-out cells of the cuticle or by materials deposited by the drying of the sweat, and that, to keep the skin free and active, constant cleansing is necessary. If systematic cleansing of the surface of the body is not practised, not only will the skin fail to separate from the blood the waste products it ought to expel from the body, but more labour will be thrown on other organs, and specially, as noted above, on the kidneys, to counteract its inefficiency. Thus uncleanliness may not only cause disease in the skin, as will be seen in the next part of this section, but may help to excite disease in other parts.

Section XI.—THE SKIN, HAIR AND NAILS.

B.—THEIR DISEASES AND INJURIES.

Eruptions of the Skin:
The *pimple* (papule), *vesicle, pustule, bleb* (bulla), *tubercle, wheal, tumour,* and *stain* (macule);
The *excoriation, crust, crack,* and *scar* (cicatrix);
Desquamation.

Inflammatory Affections of the Skin:
Inflammatory Blush (Erythema)—Erythema nodosum;
Rose-rash (Roseola—False Measles);
Nettlerash (Urticaria);
Erysipelas (The Rose—St. Anthony's Fire);
Boil (Furunculus) and *Carbuncle (Anthrax)*;
Ulcers;
Herpes—Herpes of the Lip;
Shingles (Herpes Zoster);
Pemphigus;
Eczema (Moist Tetter);
Psoriasis (Dry Tetter);
Dandruff (Branny Tetter—Pityriasis);
Impetigo (Pustular Tetter—Honey Scab);
Lichen—Strophulus—Red Gum Rash.

Overgrowths, New Growths, and Hæmorrhages of the Skin:
Barbadoes Leg (Elephantiasis Arabum);
Fish-skin Disease (Ichthyosis);
Leprosy (Lepra—Elephantiasis Græcorum);
Lupus;
Freckles; Corns; Warts; Horns; Moles (Mother's Mark—Nævi);
Purpura Hæmorrhagica;
Cancer and Epithelioma.

Itching Diseases and Diseases due to Insects:
Itching (Pruritus);
The Itch (Scabies);
Lousiness (Phthiriasis—Pediculosis);
Eruptions due to Fleas, Bugs, Gnats, Mosquitoes;
Ringworm (Tinea Tonsurans);
Favus (Honeycomb Ringworm);
Pityriasis Versicolor.

Affections of the Glands of the Skin:
Excessive secretion of sebaceous glands (Seborrhœa);
Comedones (Shilfcorns, Grub); *Milia; Wens; Molluscum;*
Excessive or altered secretion of sweat—Stinking Sweat;
Miliaria (Sudamina)—Prickly Heat;
Acne (Face Pimples)—Acne of the Beard; *Acne Rosacea.*

Injuries to the Skin:
Wounds; Burns; Chilblains and Frostbite.

Affections of the Hair and Nails:
Excess of Hair (Hirsuties); *Hairy Mole;*
Baldness (Alopecia) and *Greyness of Hair (Canities)*;
Inflammation of Nails (Onychia);
Excessive Growth of Nail—Ingrowing Nail.

The Care of the Skin, Hair and Nails.

The diseases of the skin are numerous, and many of them are troublesome. Its structure, as indicated in the first part of this section, is comparatively complicated. The true skin itself is supplied with blood-vessels and nerves, and is therefore liable to various forms of inflammatory change to which any other structure rich in vessels and nerves is exposed. But there are also to be taken into account the sweat glands and canals that are imbedded in and pass through it, and the appendages that belong to it, in the shape of hairs and nails with their attendant glands, all of them liable in themselves to various departures from a healthy condition.

Moreover, the skin ranks as a blood-purifying organ in as true a sense as the lungs or the kidneys, though in a less degree, and it may thus be not only the seat of a disease which affects it exclusively, but may likewise be a sharer in an unhealthy condition that disturbs more or less generally the rest of the body. A disease of the skin may be, that is to say, a mere local disturbance, an affection limited to the part where it is manifested, or it may be the indication and result of a general condition of body. Thus the eruptions, or rashes, that attend many special fevers, such as scarlet fever, measles, typhus and typhoid fever, &c., are evidently mere occurrences in the course of a disease affecting the whole body. No one would think of treating these eruptions by themselves, for they will gradually disappear as soon as the constitutional disturbance, in whose train they come, has passed away. But there are other eruptions, as well as affections of the skin not attended by any rash, as truly produced by a general disorder, not to be got rid of till the general disorder has been set right, that are not so readily traced to their true cause. Here, however, an error must be guarded against. It is a common belief that many skin diseases are peculiarly the expression of a "vice of blood," which is seeking an outlet in this way, and that, if this way of escape is denied to it, it will, in revenge as it were, attack deeper and more vital parts. The common conclusion, accordingly, is that the disease ought to be permitted to run riot through the skin, if it pleases, lest attempts to cure it drive it inwards. Now we have seen (p. 308) that the skin is a blood-purifying organ, that by means of its glands it separates from the blood and casts out of the body certain impurities. It is also true that in fevers, accompanied by rash, such as measles, scarlet fever, &c., the treatment consists in the use of warm baths or hot packs, and in the administration of medicines which, besides relieving the bowels, "determine to the skin and kidneys," as the phrase is, that is stimulate the activity of skin and kidneys to be more vigorous in their work of purifying the blood, to aid in "throwing off" the disease, or at least in abating its severity. As a sign that this is being done, so far as the skin is concerned, one is accustomed to view with satisfaction a rapid and full development of the rash characteristic of the disease. While this is all true, it is a totally wrong view of the facts that encourages the idea that a cure of any skin eruption runs the risk of creating disease elsewhere. It never is so. Many skin diseases are entirely local, are due, that is to say, to disturbances limited to the part affected, the cure of which implies that the disturbances have been got rid of. In those cases where the skin eruption is only a symptom of a constitutional disease, the cure of the eruption is always to be regarded as a sign that the constitutional defect is being remedied. In all cases, consequently, skin diseases should be submitted to treatment; and that treatment is the best which most rapidly and thoroughly restores the skin to its healthy condition.

In this section the eruptions of the skin that attend the acute fevers are not considered, but are discussed in the section on acute fevers. Apart from these the various affections of the skin are reviewed in this section, and are classed under different headings. Various classifications have been proposed by different authorities, none of which is employed here, the arrangement used being dictated simply by convenience. Inflammatory affections of the skin are first discussed, then growths and tumours, itching and parasitic diseases, affections of the sweat glands, affections of the hair and sebaceous glands, and affections of the nails.

First, however, as a great many skin diseases are attended by visible alterations in the surface, discoloration, or elevations of the surface in the form of eruption, &c., and since the nature of such change is some guide to the character of the disease, it will be well to explain the terms employed to distinguish between various forms of such alteration.

Various forms of Eruption (Rash), &c., of the Skin.

The pimple or papule is a solid elevation above the level of the skin, between a millet seed and a lentil in size. It apparently contains no fluid. It may be of the colour of the natural skin, reddish, bluish, or black, &c. Pimples are commonly connected with the glands of the hair, due to effusion of material prevented from escaping, or they may be due to inflammatory swelling of the papillæ of the true skin. Their presence gives a feeling of roughness to the skin, and may occasion severe itching and tingling.

The vesicle is an elevation of the upper horny layer of the skin by fluid accumulated between it and the deeper layers. It is of the size of a pimple, and the fluid is clear or milky. The thin covering may burst and the fluid escape, or it may evaporate, or the clear fluid may become yellow and a pustule be formed.

A pustule is the same as a vesicle, but instead of clear fluid it contains yellow matter—pus. A vesicle becomes a pustule if the clear contents of the vesicle alter their character as they often do.

A bleb or bulla is the same as a vesicle except in size. They may be as large as walnuts, or even hen's eggs, or still larger. The contents of the bleb may, however, be pus.

A tubercle is a solid swelling larger than that to which the term pimple is applied, but of a similar kind.

A wheal is the term applied to a raised portion of skin of greater extent than thickness. It may be of varying shades of red, and is generally flat. It is due to swelling in the upper layer of the true skin itself.

A tumour is a solid swelling, in size between a walnut and a man's fist, situated in the deeper layers of the skin.

Lastly, there is the **stain or macule, or spot** caused by a change in the ordinary colour of the skin. Spots may be of varying colour, white, red, blue, yellow, brown, &c., and of very different sizes. They are not raised above the surface. They may be produced by blood being poured out in the substance of the skin at mere points here and there or in patches. The blood spot passes through changes in colour, blue, green, and yellow, before it disappears.

These various forms of eruption are not necessarily separate and distinct kinds; for the pimple may become a vesicle, and the vesicle may change to a pustule, and the condition that produces the pimple will give rise to the tubercle if a larger extent of surface be affected. Similarly the difference between a vesicle and a bleb consists simply in the size of the area affected.

Moreover, scratching, rubbing, &c., effect alterations in the appearance of the eruption. In itchy diseases frequently the original form of the eruption is not recognizable because of the effects of scratching. The heads of pimples may be knocked off so that blood oozes in drops and hardens on the pimple, changing its appearance. The skin covering vesicles, pustules, &c., may be removed by scratching, and raw surfaces remain from which clear fluid, perhaps mixed with blood, oozes. This is called an **excoriation**. Then the fluid dries and leaves the surface covered by a **crust**, which varies in colour, according as only clear serum has been present, or that fluid mixed with blood or yellow discharge.

Cracks or fissures are apt to be produced in the skin as a result of dryness or brittleness. The term **scar** or **cicatrix** is applied to the marks left after some loss of substance in the skin. The scar is a lower form of tissue which has been produced to make good the deficiency occasioned by the disease or injury. Thus in a deep wound the cicatrix is due to the new material formed between the lips of the wound to effect their union, and the cicatrix, that marks the site where an ulcer has been, is formed of new tissue attempting to take the place of that destroyed by the ulcerative process.

Scales are masses of cells from the horny layer of the skin shed as a result of some change in the deeper parts of the skin which has deprived them of nourishment. Thus scales are copiously shed in chronic inflammatory conditions of the skin. In scarlet fever and other acute diseases parts of the horny layer of the skin may separate in large masses. This separation of masses of cells of the epidermis, whether in the form of scales or in larger portions, is called **desquamation**.

DISEASES OF THE SKIN.

Inflammatory Affections.

Inflammatory Blush (*Erythema*). This is in the form of patches of a dusky red colour caused by increased flow of blood through the vessels of the part. Sometimes the patches are slightly raised above the level of the skin. In the simplest form the redness appears suddenly and vanishes suddenly, and is accompanied frequently by some degree of tingling. It occurs mostly on face and neck, arms, and trunk. After the redness has passed fine scales are separated. This is most often due to some digestive disorder. Another form is caused by rubbing of one surface of the skin upon another, as seen in children, and may lead to chapping of the skin. Frequent bathing is all that is necessary for this, followed by careful drying, and perhaps the use of glycerine or vaseline. In one kind of erythema occurring generally on the backs of the hands and feet, sometimes extending to the arms and legs, and seldom to the face, after the diffused redness has passed, pimples are perceived over the affected patch. They fade in a few days, and are not attended by any special symptoms. The most serious form of the disease is **Erythema nodosum** (see Plate IV.), in which dark red oval swellings from a half to several inches long, appear in crops over the front of the lower limbs in particular, and other parts of the body. The patches are hot and painful, but

not itchy. In a few days the red colour becomes livid, and then changes to yellow and green, like an ordinary bruise. Neumann states that children have been brought to him from schools, the teachers of which were accused of having beaten them, whilst really they were suffering from erythema nodosum. Loss of appetite, debility, feverishness, headache, &c., precede and accompany the disorder, which chiefly attacks young persons and females. It usually disappears after a few weeks. Some kinds of inflammatory blush are associated with rheumatism.

Treatment.—All that is chiefly required is attention to the diet and to the condition of the digestive organs. An occasional dose of saline medicine (Eno's fruit salt, citrate of magnesia, &c.), or to children fluid magnesia, is useful. To weakly persons acid and bitter tonics may be administered. In females some irregularity of the monthly discharges may be the cause of the trouble.

Rose-rash (*Roseola—False Measles*) is the name given to an eruption in which red patches appear on chest and neck, and sometimes on face and arms. They fade on pressure, but reappear on removing the pressure. Lasting only a few days, they soon fade, and often slight shedding of scales of the skin follows. Before and during the eruption feverishness, headache, and disturbances of digestion occur. The affection is apt to be mistaken for measles or scarlet fever, but it is not contagious. Only rest for a day or two is required in the way of treatment.

Nettle-rash (*Urticaria*, from *urtica*, a nettle). In this disease the eruption is characterized by wheals, which are at first red and spread, becoming then white in the centre (Plate IV.), The development of the wheals is accompanied by itchy stinging sensations, such as the sting of the nettle occasions. Fresh crops sometimes break out at intervals on different parts of the body, though each wheal quickly fades. The chest and back are more commonly attacked than the limbs. The face may be affected. For weeks or months the eruption may go on disappearing from one place only to appear on some other part, although it may last for only a few hours altogether. In some cases fever, shivering, headache, and vomiting attend the outbreak, in others these symptoms are absent. Nettle-rash may be excited by irritation of the skin, by bites of fleas, bugs, &c., by stings of various kinds, or by the application to the skin of substances like turpentine. It often arises from the taking of particular kinds of food, drink, or medicine, such as oysters, lobsters, fish, pork, sausages, cheese, cucumbers, mushrooms, copaiba, turpentine, &c. The presence of worms in the bowels, and in women irregularities of the monthly periods, pregnancy, &c., occasion it. Often no cause can be assigned for the attack. It is not contagious.

Treatment.—The bowels should at first be freely opened and thereafter well regulated. The diet should be carefully scrutinized. It is sometimes necessary to leave one thing out after another in order to discover whether the diet is causing the affection. Nor ought one to overlook the fact that gnats or bugs may be the exciting cause. All external sources of irritation of the skin should be removed, linen or cotton being worn next the skin. The person should be kept cool and be lightly clad. Cold sponging, and sponging with vinegar and water, relieve the irritation for a time. It is an affection, however, that very often resists all treatment.

Erysipelas (*St. Anthony's Fire—The Rose*) is an inflammation of the skin spread over a considerable area, not in patches. In it not only is there a temporary overfulness of the vessels of the affected part, but material passes from the blood-vessels into the substance of the skin. The part is not only, therefore, hot and red, but it is also swollen, and perhaps brawny. Usually it begins with a feeling of chilliness, headache, fever, quick pulse, furred tongue, and vomiting. The affected part is painful and itchy, and becomes red and shining. At first the redness is bright and disappears on pressure to return, but later it assumes a darker hue. In slight cases the redness fades in a few days, and the swelling disappears. It tends, moreover, to pass from one part to another. In more severe cases the swelling may be great, the colour becomes livid, and parts of the skin feel "boggy" to the touch, and may die and slough away, or abscesses may form. It often attacks the face, extending from one side to the other, and sometimes involves the whole head, causing subsequent loss of hair. In severe forms the pulse becomes rapid and feeble, breathing is hurried, and delirium occurs. Low, muttering delirium, tremulousness of the limbs, dry black tongue, and the passing of the contents of the bowels in bed, are bad signs.

Erysipelas is contagious. Specially has this been observed in hospital wards, and particularly in the surgical department, from its prone-

ness to start from a wound. In the wards of lying-in-hospitals it is a very serious disease, spreading rapidly and setting up puerperal fever. Persons who are not exposed to its influence through a wound or other raw surface, but who live in bad circumstances as regards diet, fresh air, and cleanliness, are also predisposed to be attacked, and if attacked are less able to overcome the disease.

Treatment should always be regulated by a physician, since the disease may rapidly assume a dangerous form. It is directed mainly to sustain the general strength, and consists chiefly in the administration of nourishing diet, beef-tea, eggs, milk, &c. The bowels should be regulated. The chief medicine employed is tincture of steel, of which 10 drops should be given in water every four hours. Stimulants are often necessary. Various applications to the affected part have been suggested. Dry cotton wool to exclude cold and irritation is perhaps best. Of course abscesses require opening. A patient who has recovered from an attack ought to exercise great care against its return.

Boil (*Furunculus*) is an inflammation of a small part of the true skin, usually beginning in the glands of a hair sac. The inflammatory material poured out causes a hard swelling, which is red, painful, and throbbing. Matter forms and appears at the top of the swelling as a yellow point. The matter bursts through and continues to be discharged through a minute opening for some time. Through the opening there may be seen deep in the part a yellow centre or "core." By the time this is loosened and discharged, the swelling and redness are greatly lessened, and the cavity fills up. When all tenderness and swelling have passed away a scar remains to mark the spot. In a "blind boil" the process is the same, but the boil is deeper and slower in reaching the surface.

A boil may be produced by some irritation applied to the part at which it appears. Usually, however, it is an indication of a depressed state of health, particularly if one occurs here and another there at intervals, or if crops of them break out.

Treatment.—One may be successful in checking the development of a boil in its early stage when it is felt as a hard painful spot in the skin by the application of some soothing substance, such as a paint made of equal parts of glycerine and extracts of opium and belladonna. When the boil is hard and stinging hot applications are most soothing. They are, however, apt to bring out pimples round the boil, which may themselves develop into boils. To prevent this it is well to cover the surface of the skin for some extent with adhesive plaster, an opening being cut in the plaster opposite the top of the boil. It often hastens cure, and aids in the removal of pain, to have a surgeon freely open the boil with a lancet. Besides such local treatment the patient's bowels should be relieved by seidlitz-powder or similar medicine, and nourishing food, quinine and iron tonic, &c., should be administered.

Carbuncle (*Anthrax*) is an inflammation of the true skin and tissue beneath it akin to that occurring in boils. It is more extensive than the latter, and instead of one has several cores. Considerable portions of the skin are apt to be destroyed and to separate as sloughs. It is associated with a bad state of general health, from which condition its danger arises, for it may threaten life by exhaustion. It begins as a painful hard swelling, increasing in size, and deepening in colour, situated most commonly on the back of the neck. The pain is severe and throbbing, and fever is marked. In a few days several openings are formed on the surface, from which discharge escapes, and through the openings yellow "cores" are seen. The skin becomes undermined, and the openings unite to form a large one, revealing an ashy-grey slough in the deeper parts. As this is discharged a cavity is formed extending some distance under the skin. Often pieces of the skin die and are thrown off, so that a large ragged wound is formed, from whose surface shreddy matter separates. The exhaustion is often great, and extensive parts of the skin are more liable to die because of the general weakness.

Treatment.—Nourishing and stimulating diet is of the utmost consequence. Quinine and acid tonics (see PRESCRIPTIONS) are to be given. The local treatment is similar to that prescribed for boil. Carbuncle is frequently fatal from exhaustion or blood-poisoning, and from the first a competent surgeon should have charge of the case.

Ulcers of the skin are common. An ulcer implies that the skin is broken, and that there is loss of substance. Owing to softening and breaking down of the skin an open sore exists. Various circumstances may encourage the formation of an ulcer. Thus some persons may be in such a depressed condition of health that the slightest scratch or bruise will lead to breach

of the surface and the formation of an ulcer. Again, while the general health may be of a fair average, some particular part may be subject to influences that readily provoke ulceration. Thus persons who suffer from enlarged (varicose) veins are liable to have ulcers forming on the legs on slight provocation. Owing to the dilated veins the circulation is so sluggish that the nourishment of the skin is impaired, and a scratch or knock or bruise gives rise to a sore difficult to heal. Such ulcers occur often in persons who have to stand most of the day, laundresses, cooks, &c., specially if they are stout of build; and the ulcers are on the legs because these are the lowest parts, from which the return of blood is most impeded.

Ulceration may find its starting-point in a cut, bruise, or wound of any kind.

Ulcers heal by what is called **granulation.** The broken surface is covered over by minute red elevations (the granulations) or hillocks of newly-formed tissue, which readily bleed. From the surface fluid oozes away, consisting partly of a clear fluid (serum) and partly of matter (pus). By the growth of the granulations the loss of substance is gradually made up. Round the edge of the sore there is a slow encroachment of the upper layers of the sound skin, so that the extent of the sore gradually diminishes, and a thin covering of scarf-skin spreads over it. Ultimately the sore is entirely covered over, but retains features distinguishing it from normal skin—its thin covering, not of true skin, and its pale transparent appearance. In medical language a cicatrix or scar remains.

There are various kinds of ulcers. The late Professor Syme of Edinburgh classified them as—1. *Healing ulcers*, 2. *Ulcers failing to heal from excess of action*, 3. *Ulcers failing to heal from defect of action*, and 4. *Ulcers failing to heal from peculiarity of action.* It is often a nice point for a surgeon to decide what kind of ulcer he is dealing with, and what is the appropriate treatment. The probability is that an unskilled person, attempting to cure an ulcer, will only aggravate the sore. Here we shall only try to indicate what such a person may do, in the absence of proper surgical advice, without running such a risk.

1. The **healthy ulcer** is known by the small, firm, red elevations that cover it. They are sensitive when touched and readily bleed. There is a slight discharge of healthy matter. The edges are level with the surface, and a thin blue line indicates the advancing layer of skin.

The **treatment** of this kind of ulcer consists simply in giving it fair-play. Let the part be kept at rest and raised—not hanging. Let the part be cleaned by allowing pure tepid water to flow over it from above. Cover it with a piece of lint wet with clean water, and over the lint place oiled silk, the whole being retained in position by a well-adjusted bandage. The person's general health should be maintained.

2. The **ulcer failing to heal from excess** of action has red, swollen, angry-looking edges, uneven surface, and thin offensive discharge, and there is aching or throbbing pain.

Treatment.—Raise the part affected and ensure rest. Let the person's bowels be opened by such medicine as seidlitz-powder, and let attention be given to the patient's health. To the ulcer itself apply warm bread poultices to relieve the pain and swelling. If this is not sufficient, a lotion, made of ½ ounce of solution of acetate of lead and the same quantity of glycerine to 5 or 6 ounces of water, may be applied, on lint covered with oiled silk. When the irritation has passed the treatment for healthy ulcer is to be adopted. Irritable ulcers in full-blooded people, who live "not wisely but too well," will be greatly helped by the free use of seidlitz-powders, or mineral waters like Hunyadi Janos.

3. The **ulcers failing to heal from defect** of action have flabby, large granulations, to which the term "proud flesh" is applied. The discharge is thin and watery, and the ulcer is painless. In other forms the surface is glazed, no granulations being present, and the edges are raised, hard, and irregular.

Treatment.—Those exhibiting "proud flesh" are best treated by firm pads placed on the surface and kept there by moderately-firm bandaging. Under the pads an astringent dressing may be applied. For that purpose a solution of 2 grains of chloride of zinc in an ounce of water may be used, diluted if found advisable. The same solution is valuable for the glazed ulcers. The patient should have nourishing diet and quinine and iron tonics.

4. **Ulcers failing to heal from peculiarity** of action are of various kinds. They may be due to syphilis, scurvy, scrofula, &c., and as a rule their treatment consists of treatment of the constitutional condition which maintains them, which it is the business of a surgeon to detect. Belonging to this class also are ulcers caused by dilated veins, occurring commonly on the legs. Anything that supports the veins will help the ulcer, notably a well-adjusted elastic stocking.

Ulcers prevented from healing by some constitutional state are often sloughing ulcers, whose edges rapidly break down, are very irregular and undermined. It is to be noted that in the simple suggestions for treatment given here no mention is made of the use of bluestone or caustic. These are sometimes used by surgeons, and if used judiciously may often be of great value, but should never be taken into the hands of any one else.

It is not to be assumed that one or other of the methods noted will be sure to heal any ulcer. Many ulcers are extremely obstinate and baffle even skilful surgeons. But what it is desirable to insist on is that, if people must treat ulcers on themselves or others without medical advice, such simple means as are mentioned are the only safe methods. In all cases if after a few days' trial the person fails to produce an improvement in the sore, he should seek advice whenever possible.

Herpes is the name given to an eruption characterized by groups of small sacs (vesicles) filled with a clear fluid. An itching or burning sensation announces the approach of the eruption, and the same sensation accompanies it. The part of the skin attacked is swollen and inflamed before the vesicles form. Two or three days after the eruption is fully formed the clear fluid becomes turbid, and finally dries up into a crust. It lasts not more than 7 or 8 days. The eruption may occur on the lips, on the lining membrane of the mouth and tonsils, and rarely the tongue, and on various other parts of the body. It may occur on the private parts. In all its forms it is accompanied by some slight disturbance of general health, fever, headache, &c.

Perhaps the commonest form is that which occurs on either the upper or lower lip during an ordinary cold, and called **herpes labialis**, herpes of the lip. It is familiarly known to everyone as one of the signs of a cold. When they occur on the throat they form little ulcers by the bursting of the vesicles.

Another form is apt to occur in young people at particular times of the year in the shape of clusters of the small blisters about the elbows and knees and other parts.

Treatment.—Painting the part when the tingling sensation begins with tincture of camphor may check the eruption; but once it is formed it should be left alone.

Shingles (*Herpes Zoster*) is an eruption of the same kind as that just described. It is, however, much more extensive, and it attacks in particular certain well-defined parts of the body. It seems to have a nervous origin, for it follows the course of some particular nerve. Thus it is common on one side of the chest, from the middle line of the back round to the middle line in front, but not crossing that line. This is the course of one of the nerves running between the ribs. It may occur on both sides, not by extending itself, but because it attacks two different nerves. This, however, is rare. It may occur over the belly in the same semicircular way, also over the cheeks and nose, or over the forehead from the inner corner of the eyelid, following the line of one of the sensory nerves of the face; and in other localities.

It is preceded by stinging neuralgic pains for 24 or 48 hours, then the eruption comes out in numerous groups (Plate V.) over the inflamed skin, and is attended by intense irritation. The eruption goes through the same stages as already noted of ordinary herpes, and yellow crusts form. The vesicles attain their full development in 5 or 6 days, and in 8 or 10 days usually the eruption has disappeared. Sometimes successive crops delay the disappearance. Often, especially in the aged, the pain does not cease with the disappearance, but may continue for weeks and months. It does not recur.

Treatment.—No known treatment is of any use to check the disease. It must be allowed to run its course. All that should be done is to diminish the irritation as much as possible by dusting the part with powder, and covering it with cotton wool, held in position by a bandage, to prevent rubbing with the clothes. Sometimes the pain is so great that it is necessary to give doses of opium to relieve it and to procure sleep. When the neuralgic pain continues quinine, iron, and arsenic tonics are valuable. (See PRESCRIPTIONS—TONICS).

Pemphigus is a disease of the skin attended by the formation of blebs (bullæ). These are like blisters, larger than vesicles, varying in size between a millet-seed and an apple, and are filled with a clear yellowish or muddy fluid. The skin on which they rest is slightly inflamed. They come out in successive crops over various parts of the body, except the head, palms of the hands, and soles of the feet. The fluid of the blebs may be absorbed, and the skin over the collapsed sac becomes dry and separates, or the bleb may burst and leave an exposed surface.

Acute cases of the disease occur rarely in

adults, but not unfrequently in children. They run their course in three to six weeks without much constitutional disturbance being produced, unless the blebs are large and in frequent crops, when the itching becomes very severe. Only in ill-nourished children, when the eruption is extensive, need any fear of the result be entertained.

Treatment.—Nourishing and generous diet is of great importance. The principal medicine to give is arsenic, but so much caution is necessary for its administration that it should be left entirely in the hands of a physician. Quinine and iron tonic may be given. The skin is to be frequently bathed.

Eczema (*Moist Tetter—Running Scab*—see Plate IV.) in its beginning consists of an eruption of pimples or vesicles or pustules on inflamed and swollen skin. The vesicles burst or are torn by scratching, and a red weeping surface is produced. The gummy fluid from the torn surface may dry on the inflamed part and crusts be produced. If the crusts be removed the dull red surface becomes dry and covered with white scales. Thus the appearances presented by the part affected with eczema may vary with the stage of the affection. There is usually intense itching, and the scratching that is occasioned leads to an extension of the disease. The chronic forms of eczema are the most common, but acute attacks are also frequent. They may last not more than a fortnight, or may return in successive attacks, and finally pass into the chronic type. A sense of chilliness along the back and feverishness usually precede the acute form; the skin becomes red and swollen, and within 48 hours the eruption appears, which, in a week or ten days, passes through the various stages described. In chronic cases the place affected has often something to do with the appearances produced. In eczema of the head the oozing fluid from the inflamed surface, mixed with secretion from the glands of the hair, readily forms matted crusts among the hair; and, if the part is not kept clean, the condition may spread till the whole scalp is affected. Moreover, in the offensive mass lice, maggots, &c., breed. This is common among ill-nourished unhealthy children (is termed **scald-head** or **milk-crust**), and may last for years if not treated. When the scabs are removed a red thickened surface covered with scales is laid bare. The disease easily extends to the lobes of the ear and into the canal of the ear in the form of red cracked skin, weeping or scaly, or coated with scabs. The nostrils may be affected and their openings plugged with thick scabs, the skin of the lip being red and swollen. Eyelids and eyebrows are often involved in the disease.

Eczema also occurs on the surfaces of joints, particularly the knee-joint, or the surfaces on which the limb moves when bending takes place. Owing to the frequent movement painful cracks are formed, and the skin is red, thickened, and crusted. A similar form occurs on hands and feet. That of the feet is ascribed to the pressure of boots, and is on the back of the foot usually; that of the hands is commonly due to irritating substances among which the person works. Thus **grocer's** and **baker's itch** are forms of eczema, occurring on the hands and arms, and set up by working among salt, sugar, &c., and by the action of heat and moisture. In eczema of the genitals itching is severe and leads to much scratching and tearing. The surface becomes red and thickened, and the affection may extend downwards along the thigh, upwards towards the abdomen, and back to the anus, where it may lead to the formation of painful itching fissures.

Eczema may be caused by the direct action on the skin of irritating agents, examples of which have already been given. Mere scratching will sometimes be sufficient to produce it, the pressure of clothes, &c. It also results, however, from constitutional conditions.

Though eczema is curable, relapses are very common.

Treatment.—Eczema is treated chiefly by applications to the affected part, and not by drugs administered internally. It is a common notion, but quite a mistaken one, that the cure of the disease, so far as it affects the skin, will tend to "drive it inwards" on some more important organ. No such idea ought ever to be permitted to stand in the way of adopting appropriate methods to obtain a cure. A great variety of preparations are adopted, and many cases are very obstinate. It is, therefore, necessary to have the treatment guided by a surgeon. The following simple directions may, however, be found useful. In the stage of swelling and heat cold-water dressing will afford relief. After the eruption has appeared dusting with finely-powdered starch, white oxide of zinc powder, or chalk, may be tried. Scabs should be removed after softening with oil, or bread-and-water poultice, or, perhaps best of all, poultices of mashed turnips. These latter are specially valuable in eczema of the scalp. When the scabs have all been removed simple ointments

like vaseline may be applied. A very valuable ointment is made of the yellow oxide of mercury (yellow precipitate) 1 drachm, oil of sweet almonds 1 drachm, lard 6 drachms. This ointment may be applied to the eyes as well as to any other part. For eczema occurring on two surfaces that rub on one another careful bathing and drying, and then the application of vaseline are sufficient. In particular *all irritating applications are to be avoided.* If the person suffer from depressed health it is advisable to use quinine and iron tonics, and to obtain change of air.

Psoriasis vulgaris (*Diffuse Dry Tetter*—see Plate V.) is a chronic disease of the skin, in which thick layers of shining pearly scales are formed on a reddened and thickened skin. The scales are easily separated by the nails. There is little or no itching, and thus, in one chief point, psoriasis differs from eczema. Large portions of the skin may be affected, or the eruption may occur in little heaps, of the size of pin heads, which gradually enlarge till masses like drops of mortar are produced, and still enlarging may become like coins in size. These patches tend to heal in the centre and spread at the circumference, circles and figures of 8 being produced. As the disease heals the patches become less raised, the scales being detached, and others not being formed with the same rapidity, and the redness gradually fades till the skin resumes its natural colour. The most common places for psoriasis are the backs of the elbows and the front of the knees. It may also form a ring round the forehead and ears.

Psoriasis may be cured, but is always liable to return. It is not contagious, but is distinctly transmitted from parents to children.

Treatment.—The most successful application is made of a powder called chrysophanic acid, of which 15 grains are combined with 1 ounce of lard or vaseline. This may be rubbed on the part at once, or after scales have been removed by the use of soft soap. If it irritates too much the ointment may be weakened or discontinued for a time. It stains clothing a deep colour, not removed by ordinary washing. Benzole, however, or a weak solution of potash or chlorinated lime will remove the stains. It is commonly necessary to combine with the ointment the internal administration of arsenic. A good way of avoiding a mistake with the dose is to have the drug put up in pill, each pill containing 2 grains dried sulphate of iron, $\frac{1}{16}$th of a grain arseniate of soda, and 1 grain extract of gentian. One pill should be taken thrice daily *after meals.* The pills should be continued for a long period, *should never be stopped abruptly,* but when it is desired to cease taking them, the dose should be gradually diminished, $2\frac{1}{2}$ pills daily, then after some days 2 pills daily, and so on, till, after the lapse of a fortnight or so, the dose has been gradually reduced to nothing. *On the whole, however, such drugs should not be taken without the direction and guidance of a physician; and no one, of course, would give such a medicine to children unless the correct dose were regulated by a medical man.*

Dandruff (*Branny Tetter—Pityriasis*) is a chronic disease of the skin, in which a quantity of fine scales is continually being produced and shed. The skin is sometimes slightly red, and there is some amount of itching present. Any part of the skin may be affected, but the scalp is specially apt to be the seat of the disease, chiefly in children and old persons. It is a very chronic affection. The distinguished German authority on skin disease—Hebra—has shown it to be really due to excessive secretion of the glands connected with the hair follicles—the sebaceous glands (p. 308).

Treatment.—A free use of soap is advised or the use of an alkaline solution, such as the carbonate of potash (salt of tartar) of the strength of 60 grains to the half-pint of water. An ointment consisting of one part of red precipitate ointment and three of lard is useful for the scalp.

Impetigo, Plate V. (*Pustular Tetter—Honey Sickness—Honey Scab*). This is an inflammation of the skin in which a flattened eruption containing matter is formed. The matter soon dries up and leaves yellow crusts or scabs. When the scabs are removed a raw surface is left. Heat and itching are severe. It occurs on the face and head and sometimes on the hands. It is accompanied by feverishness and sensations of chilliness. The disease runs its course in about a fortnight, but may be prolonged by successive crops. The matter of the pustules is capable of producing pustules on healthy parts by being inoculated.

Treatment.—Remove the scabs by the use of oil and poultices. Thereafter the ointment recommended in the immediately preceding article, with the addition of 20 drops of carbolic acid, well mixed, is to be applied to the affected parts.

Lichen Simplex, Plate V. (*Strophulus—Red-*

gum Rash). Lichen is characterized by an eruption of minute red pimples, which last about five or six days, are accompanied by much local irritation, itching, and tingling, and sometimes constitutional disturbance such as headache and feverishness, and whose disappearance is followed by slight shedding of scales of the skin. The pimples are solid, that is contain no fluid, and make the skin feel very rough. The face or arms are usually affected, but other parts also. The tops of the pimples may be torn off by scratching, and a minute crust of blood may cover them, altering the appearance of the eruption. The eruption may be mistaken for measles.

Strophulus, Red Gum, or Tooth Rash, appearing in infants, is similar to the eruption of lichen, and has been classed with it.

Treatment.—Mild opening medicine should be given, to children fluid magnesia. Tepid baths are of great use in allaying irritation, and should be frequently employed. All irritating agents should be removed from contact with the skin. Thus flannel should not be worn next the skin. Plain diet, milk, &c., is the most suitable. Internal remedies are sometimes necessary, but these should be prescribed by a physician.

Overgrowths, New Growths, and Hæmorrhages.

Barbadoes Leg (*Elephantiasis Arabum*) is so named from its frequent occurrence in Barbadoes. It is common in hot climates—the West Indies, India, Arabia, Egypt, China, and the west coast of Africa.

It consists of an overgrowth of the skin and connective tissue, attended by inflammation, and involving blood-vessels and lymphatics. The parts usually affected are the legs or the genital organs. The skin is so greatly thickened and thrown into folds, and the feet and toes are so masked, when the leg is affected, by the enormous overgrowths, that the appearance of an elephant's leg is produced, hence the term elephantiasis. When the genital organs are affected, tumours of great size may be formed, reaching down towards the knee or beyond it. Tumours of this kind weighing 100 pounds have been removed by operation.

Symptoms.—The disease begins by attacks of fever occurring at intervals, like attacks of intermittent fever, and accompanied by inflammation and swelling of the affected part. When it occurs in the genital organs these parts are swollen, the pain is often intense, passing up the groin, and accompanied by vomiting and other signs of constitutional disturbance. The lymphatics may become dilated, forming blebs from which lymph may escape. With the recurring attacks the overgrowth of the skin gradually occurs, until the great size and remarkable appearances already noted are produced. Large ulcers are sometimes formed in the skin, from which a foul discharge escapes.

The **cause** of the disease is not understood. Some are disposed to regard it as hereditary, while others are disposed to regard it as an affection of lymphatic vessels. Large numbers of a parasite (the *filaria sanguinis hominis*—see p. 238) have been found in the blood of those suffering from it. Climate, there is no doubt, has much to do with it—many believing it to be due to malaria—and the removal of the person from the place where the disease prevails, if accomplished in the earliest stages, is one of the best means of treatment. Men are equally liable to it as women, but it rarely attacks before puberty.

Persons may suffer from elephantiasis for years without the general health suffering, the increased growth being arrested, or slow overgrowth going on without recurrence of fever. The progress of the disease may thus be slow.

Treatment.—It is sufficient to state here that the best thing is to remove the patient from the district to some place where the disease does not occur. Europeans who contracted the disease in India have recovered on returning to Europe. Removal must, however, be very early. The tumour may be removed by surgical operation, and this should always be done where it occurs on the genitals.

Fish-skin Disease (*Ichthyosis*) is an affection in which there is an enormous overgrowth of the scarf-skin. The true skin is also thickened. Furrows are deepened, and thus the skin is mapped out into irregular areas, and the appearance of crocodile's hide produced. Masses of the overgrown cells may vary in colour, being of a pearly colour, or varying to brown and black. The disease is usually most marked over elbows and knees. Sometimes the only inconvenience produced by it is slight itching. The disease may be transmitted from parent to child, and commonly becomes apparent in the child at about two years of age. It is not fatal, but does not easily yield to treatment, though it may be improved for a time.

Treatment consists in frequent warm baths,

and rubbing the skin with oil, soft soap, &c., to soften and remove the scaly masses.

Leprosy (*Leprosy of the Jews, Lepra, Elephantiasis Græcorum*). This is the leprosy spoken of in the Bible, and is to be distinguished from Elephantiasis Arabum—Barbadoes Leg. It was at one time prevalent in England and Scotland, but is now extinct. It flourishes in Norway and Iceland, the coasts of the Black Sea and Mediterranean, in Madagascar, Mauritius, Madeira, the Greek Archipelago, East and West Indies, Palestine, &c.

It is probably contagious, though that is not certain. At anyrate, it is transmitted from parents to children, more frequently by the mother than the father. It usually commences in early adult life. It seems to have arisen in marshy districts on the banks of the Nile; and it was at its worst during the Crusades of the eleventh and twelfth centuries.

Three varieties of leprosy are described. One form is spotted leprosy, in which reddish coppery spots appear on the skin, and are met with on the mucous membrane of the mouth, throat, nostrils, and eyes. They spread at the margins, and after a time become paler at the centre, smooth, and shining. The redness may disappear and leave a bronzed stain or an unnatural whiteness. This form may exist for a long time, appearing and disappearing. The reappearance is frequently preceded and accompanied by fever, a feeling of languor, dulness of spirits, chilliness, and a general feeling of illness. The second form is a more advanced stage. The patches are no longer discolorations of the skin, but are raised, and form tubercles, thickenings in the skin, varying in size from a small shot to a nut. They appear specially on the hands, arms, and feet, and on the face. A remarkable alteration is produced in the appearance by them. Along the eyebrows the tubercles produce a frowning look. The hair of the eyebrows falls out, a thickened nodulated appearance of the whole face results from tubercles over nose, cheeks, chin, and lips, so that a lion-like ruggedness is imparted to the face. Hands and feet become deformed; abscesses and ulcers form; fingers and toes may be lost by death of the parts. Hair disappears from the affected patches, and nails become cracked and distorted. In the third variety patches of skin become insensible, but surrounded by over-sensitive regions of skin. Wasting of the skin sets in, and wasting of muscles and bones. The fingers are remarkable for thinness. As a result of wasting deformity and mutilation are produced. The early stage of this variety is characterized by the formation of blebs on the skin, which burst and leave behind inflamed and ulcerated surfaces. When the ulcers heal, white, smooth, depressed scars, without hair and deprived of sensitiveness, remain. The various kinds of the disease may be seen on one individual.

Leprosy is a fatal disease, though it may be slow. Death may arise from exhaustion or affections of lungs or bowels. The tubercular form lasts on an average eight or ten years, and the form attended by loss of sensation (the anæsthetic form) may last for twenty years.

Treatment consists in removing the person from the district where the disease prevails, in strict cleanliness, in attention to diet, &c. The general health is to be maintained by nourishing food, tonics, exercise, fresh air, &c. Cod-liver oil, and various other kinds of oil, have been used, and may be used, but are of little value, except as they help the general strength.

Lupus (*Noli me tangere*). The term *lupus* means a wolf, and has been applied to this disease because of its destructive tendency.

It consists in the formation of little groups of cells in the substance of the skin. The nodules thus produced may soften and break down, so that ulceration is produced; or the new growth may, after a time, disappear; but absorption of the tissue around occurs, and, owing to the loss of substance, depressed white scars occur. In the common form (**lupus vulgaris**) dull red nodules, resembling reddish transparent jelly, and of the size of a pin's head or a small shot, occur in groups or scattered in the skin. They slowly increase in size and number, sometimes forming tubercles by joining. They may remain without change for a long time, and then slowly disappear, leaving a white scar lower than the level of the rest of the skin. As the nodules disappear at one part, they appear beyond, and so a considerable extent of skin may be destroyed. They occur most frequently on the face and nose.

The nodules may ulcerate, and lead in this way to great loss of the skin and structures beneath it. As the ulcer slowly heals in the centre it spreads round the margin by formation of new nodules, which in turn break down. The nose is often destroyed in this way.

Another form—inflammatory (*lupus erythematosus*)—occurs upon the face and head, appearing as a red patch on the nose, and later as

red patches on each cheek. Spreading gradually at the margin, the patches unite and produce a "butterfly" appearance, their centres becoming whitish, shrunken, and flat.

The disease attacks the wrists and trunk as well as the face, is most common between the ages of two and eighteen, tends to disappear with age, and is more common in women than men. It is not contagious. It is very tedious and very difficult of treatment.

Treatment consists in the administration of nourishing food, tonics, cod-liver oil, and in the use of caustics and other means for destroying the growth.

Freckles are brown spots of various degrees of darkness, which occur on the skin of fair people, particularly on the exposed parts, such as face, neck, wrists, and hands. The action of light brings them out, and in summer they are specially dark.

Treatment.—The best application is a lotion of bitter almonds, made by pounding up twenty bitter almonds into a paste with water, adding water to 5 ounces, and dissolving in it 2 grains of bichloride of mercury. This is very poisonous, and ought so to be labelled. The lotion is applied with a soft sponge and allowed to dry on.

Sunburn (*Tan*) consists of irregular patches of discoloration produced by the action of the sun's rays. The lotion advised for freckles is good for it.

Cloasma, often called *liver spots,* formed of patches of a pale or brown-yellow, occurs specially on the face, neck, and trunk. It is common in pregnant women. The lotion of bitter almonds may be used for this as for freckles.

Moles (*Mother's Marks, Nævi*) are spots or patches which, in some cases, consist simply of skin with excessive deposition of colouring matter, and in others of masses of dilated fine blood-vessels. For the latter see p. 247. The former kind is sometimes covered with long hairs. If it is not situated on an exposed part, the mole should be left alone. If it disfigures it may be touched from time to time by glacial acetic acid, applied by a fine brush, care being taken that no acid comes in contact with sound skin. Even should this destroy the mole, a scar will always remain. A surgeon might be able to cut it out so as to leave less of a mark.

Warts are small outgrowths of skin with its covering of epidermis. They are hard when over ordinary skin, soft when on mucous membranes, such as that of the lips and private parts, or on skin kept moist. Glacial acetic acid, used as directed for moles, is the best application. Sometimes they come out rapidly in crops, and sometimes suddenly begin to disappear.

Corns are formed by excessive growth of the cells of the epidermal layer of the skin, excited by overpressure on the part—the pressure of a tight boot, for example. The pressure of the accumulated mass of cells causes wasting of the skin beneath it, and thus the corn comes to lie in a sort of pit.

Treatment.—The feet should be frequently bathed in warm water to soften the corns, which are then rubbed down with a file or pumice stone. To protect the part from undue pressure a corn plaster is put on. It consists of a soft circular or oval pad of cotton fixed to adhesive plaster on one surface, and with a hole in the centre. The plaster is placed so that the hole is directly over the corn, and so protects it. But prevention is better than cure, and if boots of a proper size and well fitting are always worn, corns will not readily form. Soft corns, which occur between the toes, are easily destroyed by the application of glacial acetic acid.

Horns, consisting of curved brownish masses of epidermis, sometimes occur on the head. They should be cut out.

Purpura Hæmorrhagica, in which deep red spots of various sizes appear on the skin, usually of the legs, is rather a constitutional than a skin disease, and is described on p. 237.

Cancer is common in the skin and mucous membranes, in the form of **epithelioma** or **skin-cancer.** This is formed of an enormous increase of epithelial cells similar to those of the epidermis, which exist as hard nodules in the skin, slightly raised above the surface. In time an ulcer is formed, with prominent, irregular, and hard edges, with an irregular warty floor, and discharging thin unhealthy matter. Its commonest place is on the lip, and it rarely occurs under forty years of age. It is also met with on the face and on the external genital organs. If not removed early, the disease spreads to lymphatic vessels and glands. Moreover, the disease spreads in all directions in the immediate neighbourhood by multiplication of the cells, and the ulcer spreads by breaking down of the new growth.

In women cancer involving the skin of the

breast is common, but is considered in the chapter on DISEASES OF WOMEN. **Chimney-sweeper's cancer** is the epithelial form occurring in the external genital organs.

The proper **treatment** is removal by the knife; and if this is done early and thoroughly there is good hope of the disease not returning.

Itching Diseases and Diseases due to Parasites.

Itching (*Pruritus*) is a condition of perverted sensibility of the skin. It is not to be regarded as a disease in itself, but merely as a symptom of a disease, and it may accompany various disorders. Itching may be present in a very annoying degree without any eruption of the skin at all. But if it is severe, and lasts for any time, the mere mechanical injury, inflicted by the nails of the person, is likely to produce considerable changes in the appearance of the skin, in the shape of scratches, tender and bleeding spots or patches, from which the protective scarf-skin has been removed, and inflammation and thickening of the affected parts. If the itching attends an eruption the characters of the eruption are considerably altered by the tearing, the tops being scratched off pimples, which are thus made to bleed, and then the blood dries and forms a red crust or cap to the pimple, &c. The itching may be confined to parts of the body or may be spread more or less over the whole body.

1. Itching is very often due to the presence of the itch insect (see THE ITCH) or the louse (see LOUSINESS, p. 324), or to the parasite of ringworm (see RINGWORM, p. 326).

2. It may be caused by the irritation of rough clothing.

3. It may arise because of inflammation of the skin. Thus eczema (p. 318), lichen (p. 319), and sometimes psoriasis (p. 319) and pemphigus (p. 317), are accompanied by itching.

4. It may be due to constitutional and various other diseases. Thus an intense itching about the private parts is often caused by diabetes (p. 303), even in cases where no other symptoms lead to the suspicion of that disease. Itching about the anus is frequently the result of piles. In jaundice the retention of certain biliary constituents in the blood produces itching of the skin. Irritations of the intestinal canal, caused, for example, by worms, irritative affections of the womb, and affections of the kidney and bladder, may lead to it. In old people changes in the skin, resulting from old age, may cause it.

5. Certain drugs, such as opium and copaiba, after being taken inwardly, tend to produce a general itchiness of the skin.

Treatment.—As soon as the cause has been found the remedy may be easy. Insects should be destroyed, disease of kidney, womb, &c., should be treated, irritation removed if possible, and so probably the itching will disappear. Where no cause can be discovered tonics (iron and quinine) should be given; the person should not wear flannel next his skin, and frequent bathing with water in which ordinary soda is dissolved should be resorted to. A lotion is also recommended consisting of Wright's liquor carbonis detergens, ½ ounce in 8 ounces of water, and 1 ounce of glycerine. With this the parts should be sponged.

The Itch (*Scabies*). This is an itching disease due to the irritation of the itch insect (**acarus scabiei**), in which the skin is inflamed (Plate V.).

The male itch insect is represented in Fig. 147. It is just large enough to be seen with the naked eye, has eight legs, and a number of projecting spines from its under surface. The female is slightly larger than the male, being about $\frac{1}{50}$th to $\frac{1}{60}$th of an inch long, and on the ends of the four front legs it has suckers, while the hind-legs end in long hairs. In the male two of the hind-legs have suckers.

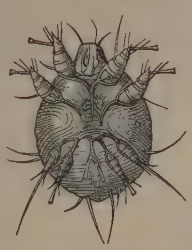


Fig. 147.—The Male Itch Insect (magnified).

When the female is placed on the skin it bores its way into the epidermis, and, after lying embedded for a little, lays an egg. To make room it bores a little further along, then lays another egg. Daily a fresh egg is laid, the insect meanwhile advancing and penetrating into the skin till it has bored a tunnel, which passes more deeply into the skin the further it is carried. With the growth of the skin and the shedding of the cast-off cells of the epidermis, the tunnel is brought nearer to the surface, till the first egg is exposed, about the time it is hatched. Fourteen days usually elapse between the laying and hatching of an egg. In one tunnel there are about fifteen eggs. The young insect has at first only six legs, two of the hind-legs being wanting till after it has shed its first skin. The young insects escape from the burrow to the surface of the skin. The females meet males, become impregnated, and proceed themselves to

burrow. The adult female insect dies at the end of her tunnel. The male insects run about on the surface. Fig. 148 represents a female acarus at the end of its burrow and a series of eggs behind it.

Fig. 148.—Itch burrow with female Itch Insect at one end and the eggs behind (magnified).

Symptoms. — The disease usually attacks the webs between the fingers, the front of the wrists and elbows, and the lower part of the belly, the nipple in the female, the buttocks and the genitals. The feet and legs are attacked in children. There is intense itching, worse at night, or whenever the person becomes warm. The scratching induced, as well as the irritation excited by the burrowing of the parasites, leads to a scattered inflammation of the skin; swollen lines, pimples capped with crusts of dried blood, blisters and pustules are formed. The chief thing to be looked for is the burrow, which is like an old pin-scratch. It is irregular in shape, from half a line to 3 inches long, with a whitish dotted appearance, the dots being the eggs, and a little mound at the deep end, where the adult acarus lies. If all the canal has been opened up it may simply appear as a dirty ragged line.

Treatment is simple and effective. The affected person should take a hot bath, and should thoroughly scrub the whole body, except the head, with soap and water. Persons with thick and not very sensitive skin may use soft soap. After the bath the whole body, and especially the parts where the eruption is, must be well anointed with sulphur ointment, either the simple or compound sulphur ointment of druggists. The ointment should be well rubbed in. If it is properly done, one application is sufficient. An ointment may be made of subcarbonate of potash (1 drachm), sulphur (2 drachms), and lard (12 drachms). In the morning after the use of the ointment a warm bath should be taken. To destroy insects on the person's clothes they should be steeped in boiling water, or exposed for some time to air at a temperature of 150° Fahrenheit, or ironed thoroughly all over with hot irons.

Lousiness (*Phthiriasis*). Three kinds of lice may be harboured on the human body—the head-louse (*Pediculus capitis*), the body-louse (*Pediculus corporis*), and the louse found on hairy parts except the head, and specially on the pubis—the crab-louse (*Pediculus pubis*), each kind limiting itself to its special region of the body. The **head-louse** is shown in Fig. 149. It has a body of seven segments, an oval head, provided with feelers (antennæ), and six legs, three on each side, which are hairy, and terminate in claws. The head has two simple eyes, and is provided with biting and sucking apparatus. The animal is able to bite into the skin and then to insert its proboscis into the wound in order to suck blood. The head-louse confines itself to the scalp, running about amongst the hairs, where it is capable of multiplying with great rapidity by means of eggs. The eggs (nits) are firmly attached to the hairs by means of sheaths, and from them the young escape at the end of nine days, and are fully developed at the end of eighteen. The lice are found in greatest abundance in the back and side portions of the head. "A single louse may lay fifty eggs within six days, which may be hatched in from three to eight days. The 'young ones' are capable of laying eggs themselves in another eighteen days or three weeks. A pregnant louse, therefore, may be the means of bringing forth some 5000 young ones in the course of eight weeks" (Professor Hebra). In women and children, because of their long hair, lice are more common than in men.

Fig. 149.—The Head-louse.

Very severe **symptoms** may be produced by the insects. Their biting irritates and wounds the skin. It also renders the skin itchy, and the person scratches. Between the two an inflammation of the skin is produced, an eczema (p. 318). The skin is torn with scratching, and blood escapes, which dries into crusts. An eruption of blisters of the size of a pin's head or a pea appears. These are torn and weeping, and the fluid dries up also into crusts. Beneath the crusts matter forms, and the hair becomes matted together and covered with nits. This condition of things, if not promptly attended to, spreads, and a foul, matted mass of scab and entangled hair is produced, among which the lice continue to breed. On the neck, but lessening from above downwards, scratches, pustules, &c., also are present, and the ears may be affected. The glands of the neck readily

become swollen, and often in children swollen and running glands in the neck are due entirely to the irritation of such a condition of affairs in the head (see p. 207).

Treatment.—Hebra advises the following treatment. A mixture of 3 ounces common petroleum, 1½ ounces olive-oil, and 2½ drachms balsam of Peru is made, and the hair treated with it down to the very roots every hour for a considerable number of hours. The head is covered with a flannel cap. After 24 or 48 hours, when the lice and their eggs will all be destroyed by the petroleum, the head is to be thoroughly washed with soap and water. The oil not only kills the animals, but also loosens the scabs, and the washing should remove them all. Matted hair is to be combed out by careful and patient combing, beginning at the ends of the hair. If an inflamed condition of head remains it should be treated as directed for eczema. The nits, though killed, are not removed by this method. To remove them bathe the hair with vinegar and water. This softens their sheaths. Afterwards they are removed by fine-toothed combs.

In milder cases, where no scabs have been formed and where all that is desired is the destruction of the lice, which are easily got at, it is sufficient to rub well into the hair some ointment of mercury, such as the blue ointment, or the red precipitate ointment.

The **body-louse** or clothes' louse resembles the head-louse, but is larger and more active. It is never met with on the head or hairy parts. It lives not on the skin, but in the folds of the clothing, whence it only sallies out to seek nourishment, obtained by piercing the surface layers of the skin and sucking.

Symptoms.—The irritation of the insect's bite produces a red spot, in the centre of which is a minute purplish speck, due to escape of blood. Severe itching is occasioned, and as the spot is slightly raised above the surface it is torn by the nails and bleeds. Scratches covered with blood-crusts are thus produced. Various other kinds of eruptions may be caused, blisters, pustules, scabs, &c. Where the itching and scratching have gone on for a long time, the constant redness of the skin excited thereby, leads to a darkening of the colour, most pronounced on the neck, wrist, and buttocks. In extreme cases boils and ulcers are produced. In spite of such signs, supplying unmistakable evidence of the presence of lice, if the person be stripped not a single animal may be found on his body, because they hide themselves in the folds of the clothing.

The **treatment** for body-louse consists in removing the garments in which the parasites lie hid. To kill them and their eggs they should be ironed with very hot irons, the folds and creases of the clothing being ironed over specially time after time. The sores on the body should be treated by simple dressings.

The **crab-louse** (Fig. 150) or pubic louse is flatter, broader, and shorter than the other forms. It lives chiefly in the hairy parts at the lower part of the abdomen—the pubic region, but may be found on the arm-pits, among the hairs of the breast, &c., but never on the head. It grasps the hairs firmly with its front feet, making its removal difficult. The nits are fixed on the hair quite close to the skin.

Fig. 150.—The Crab-louse, more highly magnified than Fig. 149.

Symptoms.—Itching is less severe than in the case of the head or body louse, but a pimply eruption may be induced.

Treatment is commonly by blue ointment of mercury. It is, however, apt to excite inflammation of the skin, and must, therefore, be cautiously used.

Eruptions produced by Fleas, Bugs, &c.

The **common flea** (*Pulex irritans*) produces rose spots with a purplish point in the centre. When the surrounding redness fades the central spot remains still dark, and cannot be made to disappear even momentarily by pressure of the finger. Within two or three days it passes through the changes of colour common to any bruise and then disappears. In sensitive skins a kind of nettle-rash may be produced.

Bugs (*Cimex lectularis*) hide in cracks of wood-work, bed furniture, &c. They are much larger than fleas or lice, and are of a rusty brown colour.

They cause intense itching and large wheals by their bites, and an eruption like nettle-rash may be brought out, which is well-marked in the morning, and fades in the course of the day, to be again well-marked next morning.

The **harvest-bug** (*Leptus autumnalis*) embeds itself in the skin, and produces a pimply eruption, accompanied by itching, which increases whenever the body grows warm, as after being in bed for some time at night.

Treatment.—The itching in any of these cases

may be allayed by a lotion of perchloride of mercury, 2 grains to the ounce of water. A stronger lotion of the same sort may be used to wash over cracks of wooden beds, &c., for the destruction of the insects. Great care must be exercised in its use, for it is very poisonous. The same end may be served by using a mixture of 3 parts unpurified petroleum to 100 parts of water. Fumigating a house with sulphur also destroys bugs.

Ringworm (*Tinea*) occurs in three varieties according as it attacks the scalp, the beard, or some other part of the body. In all cases it is due to the same cause, the presence of a vegetable parasite, consisting of minute round bodies, and of thread-like structures formed of rows of rod-shaped bodies of a beaded appearance. This is the growing fungus and its spores. To it the name **trichophyton** has been applied. Wherever ringworm occurs this is present between the layers of cells of the scarf-skin, in hairs and hair sheaths.

Ringworm of the body (*Tinea circinata*) is the name given to the disease when it occurs on the non-hairy parts of the body. It is most common on the face, neck, and trunk, and is found also on hands, arms, and wrists. It consists of small circular patches slightly raised and of a rose colour, and covered with small branny scales. Usually round the margin is a ring of very small blisters. The spot is the seat of a tingling and itching sensation. It spreads round the margins, and as it spreads heals in the centre, so that a large red ring with a pale centre is formed. When a large ring has been formed it often becomes irregular. The disease may end of itself. On the other hand it may spread and other rings may form on other parts because of the person scratching the diseased part, and carrying some of the fungus under finger-nails to some sound parts.

Ringworm of the scalp (*Tinea tonsurans*) begins by small red patches like the ringworm of the body and spreads at the margins (Plate IV.) It involves the hairs, which become penetrated by the fungus, and are dull, dry, and twisted. They are easily pulled out, and become very brittle, themselves breaking off near the skin and leaving projecting discoloured stumps. The affected patch becomes covered with a greyish white powder. Inflammation may be produced and crusts formed. The hairs, if pulled out and examined, are easily seen to be very much thickened. In advanced cases of the disease the hair follicles may be destroyed and a bald patch be left when the disease has disappeared. Several patches of the disease may exist and by spreading unite, forming one large irregular patch.

The disease of the scalp is commonest in children.

Ringworm of the beard (*Tinea sycosis*) has similar appearances—patches, red and circular, covered with fine scales, with stubbly, dirty-looking brittle hairs. The hair follicles become swollen and tender, and matter forms round them, becoming crusted. It may persist for months or years.

Treatment.—For ringworm of the body a lotion of bichloride of mercury (2 grains to the ounce of water) is often sufficient to kill the fungus. It can be frequently applied. If this is insufficient glacial acetic acid painted all round the spreading margins of the ring will usually succeed. It may be repeated if necessary. In ringworm of the head and beard the hair of the diseased patches, and for a little distance beyond, should be cut short; crusts should be removed by the application of poultices, by the use of plenty of oil, and by frequent washing with water and soft soap. The lotion of bichloride of mercury should then be applied. This treatment is much more certain of success if all diseased hairs are removed. This is done by catching them one after another by pincers and pulling them out, not one being left behind. If the patches are large, small bits may be cleared of hair at a time until, after several times, the whole patch has been cleared. The lotion should be well applied several times after all sign of the continued advance of the disease has disappeared. It may take months before the disease is finally got rid off. Meanwhile, if the person is not in vigorous health cod-liver oil, tonics, and good food should be administered, and strict cleanliness practised.

Honeycomb or **Crusted Ringworm** (*Tinea Favosa—Favus*) is figured in Plate IV. It is caused by a fungus resembling that of ordinary ringworm. To it the name **achorion Schonleinii** has been given. It attacks the scalp. Small itchy red patches appear first, then minute yellow specks, which gradually become larger till they attain some considerable size—some may even become as large as ½ inch in diameter. They form yellow crusts, depressed in the centre so as to be cup-shaped, through which a hair passes. There is itching of the parts; the hairs become dull, dry, and ash-grey, and they are brittle. In the end they may be destroyed and fall out. When the crusts are removed pits are

left in the skin, which, however, soon fill up. The crusts have a disagreeable mousy odour. The disease may last for years. It is contagious, and has been known to be transmitted from mice affected by it to the cat which caught them, and from the cat to children, whose pet it was.

Treatment.—It is necessary that the diseased hairs should be pulled out from the root. Forceps are required, and the difficulty in removing the hairs is due to their brittleness and tendency to break off short. It may take many weeks before the removal of hairs in this way can be stopped without risk of the disease recurring. During the removal of the hairs the perchloride of mercury lotion (2 grains to the ounce of water) should be rubbed into the part to destroy the fungus. Nourishing food and tonics should be given.

Pityriasis versicolor is a disease of the skin, occurring in patches of a peculiar brownish colour, and due to a vegetable parasite called the **microsporon furfur.** It begins in small spots about the size of a pin's head. They extend and unite, large irregular patches of the discoloration being produced. Itching is not great, and, on scratching, yellowish scales come from the patch. Children are seldom attacked. Persons who perspire freely and are not sufficiently cleanly, who do not use frequent bathing, may have it for years. It occurs chiefly on the chest and abdomen.

Treatment.—The affected parts should be scrubbed night and morning with soft soap and water, and, after drying, the skin should be well rubbed with the mercury lotion advised for ringworm.

Affections of the Glands of the Skin.

Excessive Secretion of the Sebaceous Glands (*Seborrhœa*). The sebaceous glands separate an oily fluid which keeps the skin moist and soft. This is produced in excessive quantity in the disease named. It occurs specially in young people between fifteen and twenty-five, on the cheeks, nose, and forehead. The skin has a greasy appearance, and minute drops of oil may be seen standing upon it. The face of a person affected seldom appears clean, because dust, &c., so readily adheres to the greasy surface. In old-standing cases the sebum forms flakes or crusts upon the skin of a pale yellow, brown, or greyish colour. When this occurs on the head the hair becomes matted together. This may be seen in children. The affection occurs also on the genital organs of both sexes.

In another form scales of dry secretion of a dirty white or pale yellow colour adhere to the surface of the skin, or the sebum assumes the appearance of branny scales, forming a fine mealy powder. This often forms on the scalp, and if allowed to accumulate forms scurf. In the disease the hair is affected and readily falls off, so that scurf and hair are continually falling from the head.

Treatment.—Thorough cleanliness is necessary. In the oily form on the face frequent washing with soap and water, and rubbing with towels, is the best treatment. Before the soap and water, oil may be rubbed over the parts to soften and bring away plugs of sebum in the mouths of the glands. If crusts have formed they should be softened and removed by rubbing with oil and then soap and water. An ointment of oxide of zinc may then be applied. Tonic treatment may also be needed.

Comedones (*Grub, Shilfcorn*) is the term applied to plugs of sebum that block the mouths of the hair follicles and glands. They appear as small dark points, and when pressure is applied by the finger-nails a little worm-like body with a black head is squeezed out. This is simply accumulated secretion, the exposed end being blackened by dirt. A parasite has also been found among the secretion—the **acarus folliculorum**, which, however, does not seem to give rise to any symptoms.

Comedones vary in size, and, if numerous, their black points are very unsightly. They are found most commonly on the face, back, and chest.

Treatment.—The accumulated material should be squeezed out by the finger-nails. Frequent washing with soap and water, followed by brisk rubbing, should be adopted to prevent their recurrence. Previous anointing with oil is an aid to the removal of the retained material.

Milia are small, white, round bodies lying beneath the scarf-skin, most commonly on the eyelids and cheeks. They are formed of sebaceous glands which have become filled with their secretion and unable to expel it.

Treatment.—A sharp needle readily slits up the cuticle covering the little body which slight pressure then turns out.

Wens are tumours formed like milia, but

much larger in size. They may attain the size of a nut or orange, and are common on the head and face. They are enormously distended sacs of the hair and hair-gland, containing accumulated sebum which may have undergone alteration.

The **treatment** is usually to dissect them out entire, or to open them out and clear out the contents. The operation, if the wen be on the scalp, is not unattended with risk. Erysipelas may arise; and great care is exercised by surgeons in operation. The rule is, indeed, that the wen is not disturbed, unless it is a source of annoyance.

Molluscum Contagiosum is a disease of the skin caused by blocking of the sebaceous glands. Tumours, similar to wens, are produced. They are filled with a milky fluid which is said to be capable of communicating the disease. They occur singly or in groups on the face, eyelids, chest, arms, and breasts of women. They are not painful. At the top of the tumour is a minute opening, through which frequently the contents of the sac may be squeezed.

Treatment.—The tumours are emptied by squeezing, after which the walls shrink so as to become flat, or they may be opened—of course only by a surgeon.

Excessive Secretion of the **Sweat Glands**, producing excess of perspiration, may occur over the whole body, as in exhausting diseases, and in weakened conditions of body after some illness, or it may be limited to parts—the arm-pit, hands, or feet. Parts thus affected often become very tender and painful, and a local eczema (p. 318) may be produced. In the case of the feet, the smell is very objectionable, and the term **stinking foot-sweat** has been applied.

Treatment.—The parts should be frequently washed with yellow soap and water. Into the part should be rubbed several times a day some of a solution made by dissolving 60 grains of tannic acid in 6 ounces of spirit. The skin should not be wiped after the application. Into the stockings of persons with sweaty feet some powdery material should be dusted—starch, lycopodium, or even common flour.

Sudamina (*Miliaria*) are small round blisters of the size of millet seeds, containing at first clear fluid, which, after twelve or twenty-four hours, becomes milky. The blisters appear like little pearls scattered about the skin. They last three or four days, then dry up, and thin scabs are thrown off. The fluid they contain is sweat, and they are produced by excessive sweating. A pricking sensation is experienced in the skin when the blisters are being developed. To this affection the term **prickly heat** or **summer rash** is applied by some. It attacks in hot climates; and the troublesome prickly sensation prevents sleep during the night.

Treatment.—*Warm baths should not be used.* The skin should be kept cool and dry, and the excessive sweating avoided if possible. Over the skin some fine powder, starch, &c., may be dusted to allay the irritation.

Acne (*Face Pimples—Stonepocks*) is a chronic inflammation of the hair sacs and of their attendant sebaceous glands. It appears as small red pimples chiefly on the face, chest, and back of young persons. They often arise after the mouths of the glands have been blocked by plugs of sebaceous matter—comedones, which the pimples surround. Sometimes the inflammation passes deeply into the skin, and the pimples extend inward, as little nodules. Often matter is formed which appears on the surface of the pimple. When the matter has been discharged the nodule may disappear, but a scar is left to mark its former place. An acne pustule may be so large as to resemble a boil. The affection usually declines after the twenty-fifth year of age or so. An eruption of acne pimples may be produced in some people by the taking of iodine as medicine, or by the application to the skin of some preparation of tar. Workmen who have to work with tar or some of its products are liable to exhibit such an effect.

Treatment.—Frequent rubbing with soap and water is recommended as one of the most efficacious means of treatment, because it softens the scarf-skin and removes some of its layers, and with them plugs blocking the sebaceous glands, the cause of the affection. When the back and chest are badly affected, hot baths greatly aid the treatment. A lotion of bichloride of mercury, one half-grain to 1 ounce of water, and glycerine, is also valuable. The treatment must be steadily persevered in for a considerable time; comedones (p. 327) should be removed by pressure, and matter should always be let out.

Acne Sycosis is a form of the affection attacking hairy parts, specially the beard. Through each of the pimples or pustules a hair is seen to pass. The pimples may come out in crops so close together, that patches of inflamed, thickened skin are formed, and separate pimples not noticed. The matter produced may, in such

cases, form crusts, pierced also by hairs. The hairs are loosened and fall out, and when the part heals depressed scars are left, on which hair does not again grow.

Treatment.—The hairs over the diseased part should be cut short. Warm poultices should be applied, and afterwards oil rubbed on to remove crusts. Thereafter the part should daily be gone over by a surgeon, and hairs from all affected parts pulled out with forceps. After each such procedure white zinc ointment, or chrisma sulphur, should be rubbed in. Hebra strongly advises daily shaving, not only to aid in curing the disease, but to prevent its return.

Acne Rosacea (*Gutta Rosea*) is an affection which appears on the face, specially the nose, forehead, cheeks, and chin, and is characterized by an intense reddening of the skin, without swelling. The redness is due to overfulness of the blood-vessels. They can be partially emptied by firm pressure with the finger, so that the redness disappears from the pressed part, but it returns on removal of the finger. The person experiences a sensation of warmth over the affected part, especially after a meal or in the evening. One form is confined to the nose, in which the lines of overfull vessels are readily seen, and the nose is shiny by increased fatty substance from the glands. But it may extend from the nose to the cheeks, forehead, and chin. The affected skin becomes thickened; and the nose is often considerably enlarged. Persons who indulge in alcohol to excess are liable to it. All kinds of stimulants, taken inwardly, increase the feeling of heat and the congestion of the part. When the disease has lasted for a long time nodules form on the skin, producing additional disfigurement.

The disease is most common in men after the fortieth year of life, and in women about the period of the change of life.

Treatment.—All irregularities of habits, &c., should be corrected if possible. The patient should live plainly and temperately, avoiding beer, wine, &c. Disorders of function ought to be attended to. The part should be well washed with soap and water, and then a sulphur ointment well rubbed into it at bed-time—the chrisma sulphur should be used, if obtainable. After several such applications, a few days should be allowed to elapse before repeating the process, since, at first, additional redness and removal of the skin is likely to result. Other methods might be adopted by a physician.

INJURIES TO THE SKIN.

Wounds, Burns, Chilblains, Frostbite, &c.

(See Accidents and Emergencies.)

AFFECTIONS OF THE HAIR AND NAILS.

Excess of Hair (*Hirsuties*).—Hair may grow in excess over large surfaces or over small areas, as a hairy mole, sometimes producing disfigurement. The hairs may be pulled out if they are few, or may be destroyed by various applications, called depilatories, if they are many. They should not be applied without advice, as they may give rise to troublesome ulceration.

Baldness (*Alopecia*).—Baldness results as one of the changes belonging to old age, due to wasting of the skin, hair sacs, &c. It may occur as a result of some acute disease, or at an unusually early age without any such cause. In both the latter cases it is undoubtedly due to defective nourishment of the hair, owing to lessened circulation of the blood in the scalp.

Treatment for preventing loss of hair, or for loss resulting from fever, consists in means that will quicken the circulation in the scalp, such as washing the head every morning in cold water, then drying with a rough towel by vigorous rubbing, and brushing with a hard brush till the scalp becomes red. A stimulating lotion should then be well rubbed in for several minutes. Wilson's lotion is made of sweet-almond oil, 1 ounce, strong liquor ammonia, 1 ounce, spirits of rosemary, 4 ounces; water, 2 ounces. At the same time generous diet, tonics, &c., may aid the restorative process.

One form of baldness, called **alopecia areata,** occurs suddenly in roundish patches. Probably the patches have existed for some time before they are noticed. They are smooth and white. Besides occurring on the head, they may be on eyebrows, cheeks, or other hairy parts. They tend to spread. When hair grows again on the patches it is fine, downy, and white, and it may remain white always, or at least for a long time. The loss of hair has been supposed by some to be due to a parasite. (See Plate IV.)

Treatment.—The spread of the disease can be arrested by painting the part with blistering fluid. This may be repeated every two or three weeks. Frequent brushing with hard brushes, the use of electricity applied by a wire brush, and various other methods, are also advised.

Greyness of hair (*Canities*) occurs usually

as a change of old age, but it may also occur in early life, and as a result of mental anxiety, shock, &c. The colour of hair is due to colouring matter developed from the papillæ from which the hair grows (p. 308). Any change of colour must begin at the papillæ, that is, at the end of the hair buried in the skin. As the hair grows the grey part advances, until hairs formerly coloured at length appear grey or white throughout their length. It takes, therefore, in all cases weeks, or at least days, before the change could be detected. There is no remedy for greyness of hair, except the use of dyes.

Inflammation of Nails (*Onychia*) may be produced by injury, pressure, &c., and sometimes occurs because of bad general health. Redness and swelling occur round the nail, and the bed of the nail is deep red. A feeling of heat and throbbing and pain on pressure are experienced. Matter forms; discharge oozes from the fold of the skin at the root; the nail becomes loose, and there is a raw tender surface beneath it. After the old nail has been shed, the new one grows slowly and the wound heals painfully.

"Ingrowing toe-nail" produces similar symptoms, limited to the part pressed on by the nail.

Treatment.—Warm poulticing will frequently give relief. The nail is also thereby softened and readily pared. In "ingrowing toe-tail" little bundles of some soft threads, torn from lint, of the length of the nail, should be laid on the nail in line with the inflamed fold, and should be gently pushed down, thread by thread, by means of some appropriate instrument, between the border of the nail and the inflamed fold. The fold is padded with fine strips of lint, and strips of sticking-plaster are wound round the toe from above downwards. By this means the nail and fold are separated. After wearing this for a day, a warm foot-bath is taken, the lint removed, and fresh strips applied. In a few days the swelling and pain will be so reduced that one may be able to remove with scissors the side of the nail.

The Care of the Skin, Hair, and Nails.—The chief aid to a healthy skin is cleanliness. The surface cells of the scarf-skin are continually being shed or rubbed off in minute masses, which are held together by the oily fluid exuding from the sebaceous and sweat glands (p. 308). This refuse matter is apt to collect on the surface, and, if it be not removed, to irritate the skin. Moreover the pores or channels of the glands are liable to become blocked, and the secretions to be thereby pent up. From both causes pimples, redness and blotching of the skin, especially sensitive skins, will readily result. Nor is the injury confined to the skin. It is an organ of purification, by whose means the blood ought to be cleansed from impurities. If cleanliness is not practised, this duty is improperly discharged, and the whole body may suffer in greater or less amount. Regularly some method ought to be adopted for removing the cast-off material, and the method is the bath—the use of soap and water, applied with moderately vigorous rubbing. The warm bath is undoubtedly the best for cleansing purposes, and the custom of taking a warm bath once or twice weekly is to be persevered in. But no one should come directly from a warm bath unless it is to get immediately into bed. Under any other circumstances the water ought gradually to be cooled down till it becomes luke-warm. The cold bath is useful not only for cleansing but for its bracing and stimulating properties. When one enters a cold bath, the stimulus of the cold to the skin excites the vasomotor nerves (p. 233) and the blood-vessels of the skin become much contracted, so that the blood is driven out of the surface into the deep parts. In a short time after coming out of the cold bath, the reaction should set in, the blood should rush from the deep parts to the surface, and a warm glowing sensation should be experienced. For a time the blood flows in greater quantity through the skin and then gradually there is a return to the usual condition of affairs. Now the effect on the nervous system and the quickened circulation that results have beneficial effects on the general state of the body. Cold bathing should not be persisted in, whether in ordinary baths or in the sea, if this reaction does not rapidly occur. If the skin remains cold and bluish, it is an indication against the cold or a warning that it has been too long persisted in. Rubbing, which should always be combined with bathing, is a great aid in hastening and ensuring reaction. Those who would like to take a daily cold bath, but are afraid of the consequences, should set themselves to work up to it, either by taking a warm bath, and gradually, day by day, diminishing the amount of warm water in it and increasing the cold, or by beginning with merely a rapid sponging on rising from bed, and gradually extending it till they are able to bear a regular cold bath. Friction with a wet towel or sheet may be em-

ployed to begin with.—A hot bath should range between 98° Fahr. and 112° Fahr., a merely warm bath not above 100°.

Soap should be used to the face as well as to other parts of the body, since nothing is so efficacious in removing the little plugs that block the mouths of the glands especially on the faces of young persons. But the soap should be thoroughly washed off, and the face bathed with cold water, before drying. Some persons, however, find soap absolutely irritating to the face. They may dispense with it, and instead add a few drops of spirits of ammonia to the quart of water with which to cleanse the face.

Cosmetics, especially those in the shape of pastes and powders that improve the complexion by covering up the offending spots, are often liable to do serious mischief by interfering with the natural functions of the skin. The wash of bitter almonds, recommended on p. 321 for freckles, may be employed with safety.

In regard to the hair too frequent washing should be avoided; and daily washing of the hair is too frequent, rendering it dry and brittle. Probably once a week is sufficient. For it, also, soap and water are the most suitable materials of cleansing. Salt of tartar, which is often put into the water, ought not to be employed. No comb or brush with sharp edges should be employed; and small-tooth combs ought not to be used. A comb should be used gently to disentangle the hair, and not to scrape the scalp, for the removal of dandruff is not aided by this means. Pomade should be employed with discretion, but only when the hair is of itself too dry. The best are those made of perfumed vaseline or chrisma, which do not become rancid.

Long hair is the better of being trimmed at the ends once every two or three weeks to prevent splitting. The practice of girls wearing short hair is one greatly to be encouraged. The crimping and plaiting and screwing up of hair requisite for those who wear it long is injurious, and is likely to lead to weakness and thinning especially at the parts where the greatest strain is exerted, very often the very front of the head.

Hair-dyes consist as a rule of a salt of lead or silver. Both are injurious, the former much more so than the latter, and all should be avoided. The idea conveyed in the term "Hair-Restorer," that a chemical preparation will restore to the hair the colour in which it is deficient without dyeing it, is a delusion, fostered by the vendor of the dye-stuff.

Nails should be cleansed with soap and water applied by means of a brush. A knife should not be employed to remove dirt from under the free edge, since it increases the space under the nail and affords more room for dirt to accumulate, while it scratches the nail, and foreign matter getting into the scratch will be removed with difficulty. The brush is, therefore, the best agent. Nails should not be so far cut, when being trimmed, as to prevent them affording protection to the finger tips. The soft prolongation from the surface of the skin on to the back of the nail at the root ought to be kept down by using an ivory presser, and not by means of a knife. If it is allowed to grow it becomes rugged and unsightly, and also painful by being torn and bleeding.

The hands require frequent washing. Those persons the skin of whose hands is dry and harsh, will derive benefit from rubbing with glycerine or vaseline. The use of the same substances will prevent and cure hacks in the skin, which if not attended to may become extremely painful.

The feet require as much, indeed more, attention than the hands. They also should be frequently washed with soap and water, and the nails trimmed. They should not be pinched up in narrow boots. The boots ought to have broad low heels, and ought to be broad enough in front to give the toes freedom. Those who are troubled with blistered feet after walking any considerable distance will find great benefit from rubbing some soft soap over the inner surface of the stocking in contact with the parts usually inflamed.

Section XII.—THE SENSES AND SENSE-ORGANS.

A.—THEIR ANATOMY AND PHYSIOLOGY (STRUCTURE AND FUNCTIONS).

The Conditions of Sensation:
Terminal organs;
Fusion of Impressions.

Touch.

The Organ of Touch:
Pacinian Corpuscles and *Touch-bodies.*
The Sense of Touch:
The sense of contact—Aristotle's experiment;
The sense of pressure;
The sense of temperature.

Taste.

The Organ of Taste:
The Papillæ (filiform, fungiform, and circumvallate) of the tongue;
Taste-bodies—The nerves of taste.
The Sense of Taste:
Difference between taste and flavour.

Smell.

The Organ of Smell:
The Nostrils and their lining membrane (Schneiderian)—Nerves of Smell;
The Sense of Smell:
How excited—Its acuteness.

Sight.

The Organ of Sight (the Eye and its Appendages):
The Orbit;
The Eyelids—their glands (*meibomian*) and lining membrane (*conjunctiva*);
The tear-gland and passages—the explanation of weeping;
The Eyeball—Its sclerotic and choroid coats—Its chambers—The pupil of the eye—Its lens—Its nervous coat (*retina*).
The Sense of Sight:
The perception of light—the blind spot—the yellow spot;
The perception of objects—Comparison between the eyeball and a photographer's camera;
The accommodation of the eye to different distances;
Normal sight, short-sight, and long-sight;
The movements of the eyeball—The muscles of the eyeball—squinting;
The information gained by the eyes—Floating specks before the eyes—Purkinje's figures—Hallucinations—Estimate of size and distance by the eye;
Single Vision with two eyes—The stereoscope;
The Sense of Colour:
Fundamental and Complementary colours:
The perception of colour;
After-images.

Hearing.

The Nature of Sound:
Musical sounds—On what their loudness, pitch, and quality depend.
The Organ of Hearing (the Ear):
The outer ear—The auricle and external canal;
The middle ear—The drum of the ear—The Eustachian tube—The small bones of the middle ear;
The internal ear—The semicircular canals, and cochlea—Corti's organ.
The Sense of Hearing:
The perception of sound—Sympathetic vibration;
The range of the ear;
The sensation of discord;
Judgments formed by the ear.

The Conditions of Sensation.—The senses are the avenues by means of which information reaches the individual regarding the condition of his own body, and concerning the outward world which surrounds him, and of the manner in which it affects him. Every living being,

even the humblest, is not a mere separate existence, having a life of its own and independent of everything else; it is a part of a greater existence; and its value is estimated by the nature of the relations it bears to that great world of things of which it is but a mere speck. The most elementary living things have no nervous system, no special apparatus for communicating outwardly. They are little masses of irritable jelly-like living material (protoplasm), capable of acting as a whole, and with no part of their substance devoted to special purposes. An advance in this structure is perceived when a living thing shows evidence of having one part of its body devoted to the discharge of one duty and another part to the performance of another duty. The rudiments of a nervous system are found in some of the lowest animals, where one cell readily affected by certain agencies—contact with foreign material, for example—is situated near the surface of the body and communicates by a slender thread with a cell, capable of contracting, placed deeply in the body. Whenever the cell on the surface is affected sufficiently, the irritation of its substance that results is communicated along the thread to the deep cell, and excites it to contract, so that the body of the organism is moved. One cell is, as it were, on the look-out, and the business of the other one is to act on receiving information. Such a simple arrangement is sufficient for an elementary organism. But animals higher in the scale are affected in so many different ways by so many different agencies that a further subdivision of labour becomes necessary. One man may be a sufficient watch on the top of a small fort, but a large town needs a multitude of watchmen, each with his own particular duty and his own special post. So in the higher animals and man certain organs are set apart to give information regarding things the body comes in contact with, their hardness, their degree of heat, &c., all that is included under the sense of touch; another organ is set apart to give information about smell, another to inform regarding taste; another organ has as its business the duty of being on the look-out for light and colour, another for taking knowledge of sounds. The senses are thus the outposts of the mind, disposed along its walls to take note of and report to head-quarters anything that comes within the range of their duty. Without them man could have no knowledge of the outward world and could hold no relations with it. The information they supply acts, in great measure, as the motives and bases of his action. It is not out of place to remark how great, then, is the need of the information being accurate, and of the outposts being properly trained to their work, lest they mislead the mind!

There are thus a number of **special sensations,** touch, taste, smell, seeing, hearing, to which is added the muscular sense, by means of which information is supplied regarding outward things and forces. Besides these, however, there are a number of **common** or **general sensations,** the need of which arises from the highly complicated structure of the higher animals. The feature of such higher animals is the multitude of different organs in the body, each performing its own part of the general work required for maintaining the life and vigour of the animal. These organs must all work in harmony, and are in communication with one another. It is necessary that the individual should have some means of knowing whether the harmony is being maintained, and should have some warning if any organ is doing bad or indifferent work. Such information is supplied by common sensations. Thus a feeling of comfort informs of general well-being; a feeling of hunger or thirst informs of the need of certain substances to maintain nourishment; a sense of discomfort informs of some disturbance, and so on.

The essentials of a sense organ are well shown in the rudimentary forms of a nervous system, where there exists (1) one cell whose business it is to receive the impression, and (2) a nerve thread to carry the impression to (3) a cell whose business it is to receive the impression, and take knowledge of it in some way or other. These three elements are necessary for a sensation. (1) There is a special structure adapted for being affected by a particular kind of influence. Thus the eye is an organ specially formed for being stimulated by the action of light, while the ear is uninfluenced by light but is stimulated by the waves of sound, and so on. The special structures are called **terminal organs.** From the special structure, whatever it may be, (2) a nerve proceeds which is in direct communication with (3) nerve-cells in the brain in the region of consciousness. This last is important to notice. The nerve-centre to which the impression, made on the terminal organ, is conveyed by the nerve, must be situated in the brain, if the impression is to give rise to a sensation. Suppose the impression for some reason or other is arrested in the spinal cord, no sensation will result. Thus the nervous chain necessary for a sensation is not identical with that described on p. 86 as necessary for a

reflex action. A man who has had his spine injured, and is thus paralysed in both legs, does not feel a severe pinch of the skin of either leg, but probably the pinch causes the leg to be spasmodically jerked. An impression has been made on the skin, which has been transmitted to a nerve-centre. But the nerve-centre is in the cord. The injury to the spine has prevented the impression being conveyed up the cord to higher centres in the brain. Thus, though the impression has been quite sufficient so to stimulate a nerve-centre in the cord as to produce a marked reflex act, the man has been unaware of the pinch; he has had no sensation. A sensation, then, cannot be produced unless the influence has been transmitted to a higher centre in the brain, and has there excited a change of which the individual becomes aware. An impression may be duly made upon a terminal organ, but it cannot properly be called a sensation until the person becomes conscious of it. *A sensation may, therefore, be defined as the consciousness of an impression.* Now, if this is understood, it is easy to perceive that a sensation may be abolished in various ways. Take, as an example, the sense of sight. A person may be blind, as we all know, because of some injury or disease of the eye, because, that is, of something wrong with the terminal organ; but that is not the only way blindness may be produced. Another person might have perfect eyes, and yet have no sight. The nerve leading from the eye to the brain, the chain of communication, might be interfered with, destroyed, for example, by the pressure of a tumour, and, therefore, though light duly fell upon the eye and produced there its wonted effect, no knowledge of it would exist because of the rupture of communication—the impression could not be conveyed to the brain. In a third way a person might be prevented from seeing. Suppose the eye and its nerve unaffected, but the centre in the brain destroyed by the progress of some disease, the impression duly made on the terminal organ and carried along the nerve would reach a disorganized centre, which could not receive it, and no consciousness of sight would arise. But there are instances of failure to see, illustrating well the necessity for activity of the centre, not dependent upon any disease. Lift the eyelid of a sleeping man, and hold a lighted candle in front of the eye, an image of the candle flame is properly formed on the back of the eye, an impression is duly conveyed along the nerve to the centre, but the centre slumbers and there is no conscious sight. A man is walking through the streets engrossed in thinking over something; a friend walks straight towards him, and the person is apparently looking directly at his friend, but does not notice him and would pass on did his friend permit. His friend's face and figure made their usual impression on the eye, which was properly transmitted to the conscious centre, but that centre was already occupied, and the impression failed to arouse a consciousness of its presence. The same facts might be illustrated in connection with any other sense, but enough has probably been already said to show what are, in general, the conditions of any sensation. Sensation, then, is the result of a change occurring in a centre in the brain, and yet when the skin is pinched we refer the impression to the skin, though it is in the brain that it is actually perceived. We think it is our ears that recognize sounds; in reality it is only the brain that takes note of them as such. This habit of referring the sensation to the terminal organ which first received the impression is the result of education and habit. When we see a light, what we are conscious of is a change in a brain-centre, and yet we refer it outwardly. If the optic nerve be irritated by a current of electricity or by a blow, we see flashes of light as vivid as if lights actually danced before our eyes. Impressions have reached the centres for seeing, coming along the ordinary channels, and produce the same changes that lights should do. In this case, however, we know the cause of the colours, and correct the conclusion we would otherwise make. The seeing centre itself may be irregularly stimulated, by some condition of the blood, for example, and the person may see things which appear as real as if they were actual external existences, but which have only a temporary existence in his disturbed brain. Thus the man in *delirium tremens* sees fantastic figures dancing and making grotesque faces at him. His seeing centres, excited in an unhealthy way by alcohol, are of themselves producing changes which, in healthy circumstances, ought only to be aroused by real things external to him. The changes in the brain have, in this case, nothing corresponding to them outside, but the brain, nevertheless, refers them to the outside as usual, and they, therefore, appear to be real things. The man's judgment being otherwise also warped by the alcohol, he cannot correct his impressions, and is consequently victimized by them.

Fusion of impressions. It is a feature of all the senses that when they are excited by a series

of impressions, in which one follows the other very quickly, they are unable to distinguish the different impressions. The series becomes fused together, and the sensation is of a prolonged impression. Thus, if the finger be gently pressed on the edge of a toothed wheel, with the wheel going very slowly, the contact of each separate tooth is distinctly felt; but when the wheel is made to turn rapidly one loses the sensation of the separate teeth, and the feeling is of an uninterrupted kind. Again, every child knows that if a piece of string, which has been on fire at one end, be whirled rapidly in the air, the appearance of a wheel of fire is produced. The one point of fire becomes a circle. This sensation is produced by a rapid series of impressions. From every point of the circle, described by the glowing end of the string, from point after point of it in quick succession, an impression reaches the eye of the glowing point as it travels round. But all the different impressions follow so hard after one another that they are not separately distinguished in the mind, which thus becomes conscious of a continuous circle of light (p. 343). It is the same with sound. If an instrument be made slowly to emit a series of sounds, each sound of the series may be recognized separately; but if they be produced with a certain rate of rapidity, one sound is heard before the one preceding has died out, and a continuous instead of an interrupted sound is heard.

Now the explanation of this fusion of impressions is the same for all the senses. It is that the sensation lasts longer than the stimulus producing it. A flash of light in the darkness may last for a very small fraction of a second, but the effect on the eye does not vanish with the flash. It continues for a very brief space of time longer, and if a second flash be produced it may again excite the eye before the first impression has faded, and so the two become blended. Most people have noticed that if a shrill sound, say a railway whistle, has been prolonged for some time, they are doubtful of the exact moment when it ceased. The sound appears to ring in their ears some seconds after it actually stopped. If it had begun again before the ringing had left their ears, probably many would not observe that it had stopped for an instant. It would seem to have only become feebler for the moment.

TOUCH.

The Organ of Touch.

The organ of touch is situated in the skin throughout its whole extent, and in the mucous membrane of the mouth and nostrils. On p. 307 the structure of the skin is described, and the two layers of which it consists are noted. It is only in the deep layer that blood-vessels and nerves are found. The nerves terminate in many cases in a peculiar way. In many of the papillæ or ridges into which the true skin is thrown (Fig. 144, p. 307) are oval-shaped bodies about the 1-300th of an inch long, formed apparently of layers of fibrous tissue. A nerve-fibre winds round this body and finally enters it. These are called **touch-bodies** or **tactile corpuscles**, and are found in the skin of fingers and toes. In the tissue under the skin of the hand and foot of man are other bodies, called **Pacinian corpuscles**, larger than touch-bodies, the largest being 1-20th of an inch long. Each one is placed on the end of a nerve-fibre, which is like a stalk to it, the fibre passing directly into the centre of the corpuscle. Besides these two special forms of nerve-endings in the skin, there are the simple terminations of the nerve-fibres in the form of a net-work in the upper part of the true skin. In all cases the nerve-endings never reach the surface. Any impression must be communicated to them through the cellular layers of the scarf-skin.

The Sense of Touch.

The sense of touch is aroused by stimulation of the nerve terminations, already described, either by mechanical means or by heat or cold. When we lay our hand on anything, the mere mechanical contact with the body produces a sensation of touch, and if the body be warmer or colder than the hand a sense of heat or cold is aroused. Touch includes three things: (1) the sense of contact, (2) the sense of pressure, (3) the sense of heat and cold.

(1) The **sense of contact** is the most important element in touch. By it we gain information as to the form, size, and other characters, smoothness, hardness, &c., of external bodies. The sensitiveness of touch varies in different parts of the skin. Where the scarf-skin (epidermis) is thinnest it is most acute; where it is thickest it is more dull. The absence of epidermis altogether does not render the part more sensitive to sensations of contact. The direct contact with the unprotected true skin occasions pain, which effectually masks the feeling of contact. The tips of the fingers, the red border of the lips, and the tip of the tongue are the most sensitive parts. Experiments have been made on the degree of sensibility of various parts to

touch, by using a pair of compasses with points blunted by pointed pieces of cork, and determining how much the compasses required to be open for the impression of each point to be felt. If the two points were very near, the sensation was of one point only, and in order to produce the sensation of two points the ends of the compasses had to be separated by varying distances according to the part of the skin experimented on. The result showed that two points could be distinguished by the tip of the tongue though they were only 1-24th of an inch apart, by the tip of the forefinger if 1-12th of an inch apart, by the red surface of the under-lip if 1-6th of an inch apart, by the tip of the nose when 1-4th inch apart, by the palm of the hand if 5-12ths inch apart; and that the points of the compasses required to be separated 1⅓ inch to be perceived as two, when placed on the back of the hand, while in the middle of the thigh they required to be separated 2½ inches.

(2) The **sense of pressure** is different from the sense of contact, for sometimes those parts which are less acute for mere sensations of touch are more correct in gauging pressures. It is by the sense of pressure that we estimate differences of weights. Another element is introduced, however, in judging of weight, when the weight is taken in the hand, and the hand moved up and down. The weight offers resistance which the muscles require to overcome, and this calls forth what has been called a **muscle sense**, a sensation produced by the muscles, caused by the resistance offered to their movement.

(3) The **sense of temperature**.—The skin also judges of heat and cold, but its judgments are in this case liable to serious error. If one hand be very cold and the other very warm, and both be placed in the same basin of tepid water, the warmth of the water will be very different to each hand. To the warm hand it will appear cold, and to the cold hand warm. We cannot, therefore, judge absolutely of temperature. Then again the thickness of the scarf-skin seems to affect the sensitiveness to heat, for parts with thin epidermis can bear less heat than parts with thick epidermis.

Pain is an excessive stimulation of the sensory nerves, and in it all finer sensations are lost. Pain at once takes the place of other sensations, whether of contact or of pressure or of temperature, at that part of the skin so deprived of the epidermis as to lay bare the true skin.

The sense of touch supplies information according to the degree of its education. A common instance of this is the use of the blind alphabet—in reading by the fingers. An untrained person cannot distinguish the form of the raised letters; all is to him confused and indistinguishable. We all know how persons who have been born, or have early become, blind train their sense of touch to supply them with much of the information they would otherwise gain by sight.

A curious illusion of contact is shown in an experiment of Aristotle's. Place a marble between two fingers, so that it touches one side of one finger and the other side of the other finger. There is the sensation of one marble. Now cross the one finger over the other so that the marble is supported by the other sides of the two fingers, the sides not opposed to one another, and roll the marble between the two fingers, the impression of two marbles will be received, more particularly if the eyes are shut. Probably this is the result of habit, for the two surfaces of the fingers could never make contact with one object, unless the fingers were crossed in this unnatural way. Usually an impression on each surface at the same time would arise from two different bodies, and as this has always been the case the habitual impression is aroused even when, by crossing the fingers, one body is made to touch both surfaces at the same time.

TASTE.

The Organ of Taste.

The Tongue and Soft Palate are the seat of the organ of taste, which consists, like that of touch, in a particular mode of nerve termination. The tongue is composed mainly of muscular fibres running in various directions, and freely supplied by nerves and vessels. It is covered by mucous membrane similar to that lining the mouth, which contains glands in the deeper layers. The surface of the mucous membrane is thrown into irregular projections, called **papillæ**, of various forms. The **filiform papillæ** are very short, fine, hair-like processes, which are exceedingly numerous over the whole surface. The **fungiform papillæ** are broader and mushroom-shaped, and are scattered over the surface. They often project as red points when the rest of the tongue is white and furred. The **circumvallate papillæ** are the largest of all, and the least numerous. They are so called because consisting of a fungiform papilla surrounded by a fold of the mucous membrane. They present the appearance of being walled round. They are found near the back of the

tongue, being ranged in two lines, passing from a point in the centre of the surface towards the sides. There are only about a dozen of them altogether. The papillæ all contain twigs of vessels and branches of nerves, and are covered by epithelial cells. In the circumvallate papillæ

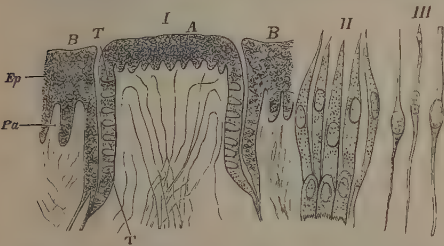


Fig. 151.—Section of Circumvallate Papillæ of the Tongue—highly magnified.

I A, Section of the central papilla. B B, Section of the surrounding elevation. Pa, Papilla of the true skin. Ep, Layer of cells—epithelium. T, Taste buds. II and III represent very highly magnified views of cells of the taste buds.

are peculiar structures called taste buds. Fig. 151 shows a section of such a papilla, in which A is the centre, and B B sections of the surrounding fold. A trench is seen to separate the centre from the surrounding fold, and at the sides of the central papillæ, in the deep parts of the trench, are a number of flask-shaped bodies (T T). These are the taste buds. They are barrel-shaped, and are formed of stave-like epithelial cells, represented in II of the figure. In the inside of the buds are finer cells, represented at III. The mouths of the buds open into the trench. The taste bodies are connected with nerve-fibres, and it is supposed they are peculiar adaptations of epithelium, readily excited by sapid substances and transmitting the impression along the connected nerve.

The tongue is supplied with sensory fibres by two nerves, the glosso-pharyngeal, a branch of the eighth cranial nerve (p. 96), and a branch of the fifth cranial nerve (p. 95)—the gustatory branch. The former confers taste on the back part, and the latter on the front part of the tongue. Branches of the former also pass to the soft palate and neighbouring parts, and confer taste on it.

The Sense of Taste.

The **sense of taste** is excited by stimulation of the mucous membrane of the tongue and palate affecting the terminations of the nerve-fibres and causing impressions to be transmitted to the brain. The stimulation seems to be a chemical one; and the substances must be in solution to produce taste. A dry condition of the mouth is not favourable to taste, and powders are not tasted till dissolved by the juices of the mouth. Various kinds of substances are capable of producing the stimulus, acid substances, alkaline and saline substances do so. Acid tastes are perceived by the fore part of the tongue, bitters by the back part and not by the fore part. Sweet and salt tastes are perceived by both. Stimulation of the nerves, for example by electricity, and without the presence of any tasty body, will excite sensations of taste. The nerve-centre for taste receives an impression transmitted by the nerve, and has no means of distinguishing between such impressions and others excited in a regular way. Similarly morbid conditions of the body may excite sensations of taste.

The taste of many substances is got rid of with difficulty. This may be due to the extreme sensibility of the nerve terminations to some substances. Thus 1 part of sulphuric acid in 1000 parts of water will be detected by the taste, and it may be that the taste remaining in the mouth is due to traces of the substance. Like other senses, that of taste may become fatigued. Repeated tasting of one substance rapidly deadens the sensibility, probably because of over-stimulation.

The sense of **flavour** is something more than taste. Flavour is a conjunction of both smell and taste. Thus, if the eyes of a person be blindfolded, and the nostrils firmly held, the person will be unable to distinguish between an apple and an onion, if one be rubbed on the tongue after the other. As soon as the nostrils are open the difference is perceived. In a similar way a common cold, causing blocking of the nose, interferes with the sense of flavour, as it abolishes smell.

SMELL.

The Organ of Smell.

The nostrils contain in their mucous membrane the structures devoted to the sense of smell. Reference to Fig. 9, p. 19, shows the cavity of the nostrils so far as formed by bone. The roof of the cavity is formed by the ethmoid bone, the upper surface of which forms part of the floor of the brain cavity, so that this horizontal plate above separates brain cavity from the cavity of the nostrils. Part of the side walls of the nostrils, as low as the floor of the cavities for the eye (see p. 19), are formed by light scroll-like prolongations of the same ethmoid bone, the remainder of the side walls being

formed of part of the upper jaw-bone. A central perpendicular plate of the ethmoid divides the upper part of the cavity into a right and left portion, and this division is continued downwards by the ploughshare bone (p. 19), and completed by gristle. The bony palate forms the floor of the nostrils. There is an opening to each nostril behind, into the back part of the throat, as well as in front. The walls of the cavities are lined by mucous membrane, richly supplied by vessels and nerves. The nervous

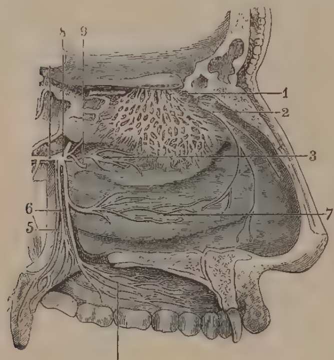


Fig. 152.—Distribution of Nerves over interior of Nostrils, outer wall.

1, Branches of nerves of smell—olfactory nerve. 2, Nerves of common sensation to the nostril. 4, 5, 6, Nerves to the palate springing from a ganglion at 3. 7, 8, 9, Branches from one of the palate nerves to nostrils.

distribution is shown in Fig. 152, where branches of the fifth cranial nerve are seen traversing the cavity and passing over its walls. The nerves of smell proper are, however, shown spreading in a thick brush over the upper and middle scroll-like bones of the outer wall, and over the upper part of the inner wall. They are found in the mucous membrane. These nerve-fibres are derived from the first pair of cranial nerves—the olfactory (p. 95), which rest on the upper surface of the ethmoid bone, and send branches through openings in its horizontal plate, which, because of the many perforations in it, is called the **cribriform** plate. The terminations of these nerve-fibres seem to be connected with epithelial cells lining the surface of the mucous membrane. The membrane is called the **Schneiderian membrane**.

The Sense of Smell.

The sense of smell is excited by the contact of particles contained in the air with the terminations of the fibres of the nerve of smell. But these, as we have seen, exist in the upper parts of the nasal cavities. In ordinary quiet breathing the air passes through the lower part of the nasal cavity, and the air in the upper regions is barely disturbed. If few of the odour-bearing particles are in the air, they may never reach the true olfactory region, and no smell will be felt. In such a case if a sudden sniff is made the air is forcibly drawn into the nostrils, passes up even into the upper chamber, and thus a faint smell becomes readily perceived.

The sense of smell is extremely acute. According to Valentin $\frac{3}{100,000,000}$ of a grain of musk can be distinctly smelt. Like taste the sense of smell becomes readily fatigued. Thus, after remaining a time in an atmosphere whose smell appears strong when we first enter it, we gradually fail to perceive the odour, and it is only when we have passed out again to the fresh air that we again perceive the difference. Smell is related to taste in the perception of flavours, as already noted under TASTE. The swelling of the lining membrane of the nostrils caused by a cold abolishes smell, probably both by preventing the entrance of air to the upper parts of the chambers, and by burying and obscuring for a time the terminations of the nervous filaments.

Sensations of smell may be excited by stimulation of the centres for smelling in the brain, owing to some abnormal condition and not due to impressions produced on the terminal organ by any odoriferous particles.

SIGHT.

The Organ of Vision—The Eye and its Appendages.

The Orbit.—The eyeball is situated in a bony cavity called the orbit, formed by various bones of the head and face (see p. 19). The cavity is padded by a loose fatty tissue, the diminution in the amount of which aids in producing a sunken appearance of the eyes.

The Eyelids are formed of folds of skin, the outer surface having the structure of ordinary skin, the inner of mucous membrane. In the body of the lids is a layer of condensed fibrous material which maintains the shape of the lids. Nearer the inner than the outer surface of the lids is a row of glands, which open on the free edge of the lid and pass from there into the eyelid in a vertical direction. These are the **Meibomian glands.** The blocking of one of these glands by the material it itself produces leads to the formation of a sty. Towards the front of the free edge of the lids are the eye-

lashes, which are thick and capable of rapid growth, so that if one falls or is pulled out another quickly grows in its place. The inner lining membrane of the lids is very richly supplied with vessels and nerves. The membrane is called the **conjunctiva**. It is continuous with the skin at the free edge. After lining the inner surface of the lid it passes over on to the eyeball. In ordinary inflammation from cold it is this membrane, whose blood-vessels are engorged with blood, that is the seat of the redness and swelling, and it is because it continues forwards over the eyeball that the eye has its bloodshot appearance in such cases. Such inflammation is called **conjunctivitis**.

In the eyelids are muscular fibres which close the lids by their contraction.

The tear-gland (lachrymal gland) and passages. Situated outside of the eyeball among the loose fatty tissue of the orbit in its upper and outer corner is the lachrymal gland. From it several little channels lead which open on the inner surface of the upper lid. The fluid produced in the gland passes out by these openings and flows over the eyeball. It is ordinarily just in sufficient quantity to keep the eyeball and lids moist, to wash off dust, &c. Having flowed over the eyeball the fluid collects at the inner angle of the lids. At this place in each lid is a little projecting point (**punctum lachrymalium**) in the centre of which is an opening. The openings communicate each with a small canal in the lid, which passes to the angle between the orbit and bridge of the nose, where is lodged a little sac—the **lachrymal sac**. The canal of both upper and lower lids joins this sac, and from it there passes a channel—the **nasal duct**, lodged in a canal in the bone, which leads into the lower part of the nostril. The fluid which has flowed over the eye is carried off by the canals and drained into the nose. The lining membrane of the eyelids is continuous through these canals with that of the nostrils, and thus redness and swelling of the nasal membrane, caused by cold, are apt to pass upwards and inflame the eyelids. The canals are often blocked by inflammation, and the fluid collects in the corners of the eyelids and flows over on to the cheeks.

The secretion of the lachrymal gland is under the control of the nervous system. Anything that irritates the eyelid leads to stimulation of sensory nerves, the impression passes to a nerve-centre in the base of the brain, from which nervous impulses travel to the gland leading to increased flow of its secretion. The first act in the process may be the excitement of sensory nerves in the nostril, as by the smelling of pungent salts. The stimulation of the same nerve-centre results, with its consequences of increased flow. A mental emotion, joy or grief, may stimulate the centre and produce similar results. In such cases the fluid is produced in such quantity that it cannot escape by the lachrymal canals quickly enough, and the excess rolls over the cheeks as tears. This is the explanation of weeping. Some people are "dry-eyed" in times of deep grief or other emotion. The explanation of this is as simple. The nervous influence acts on the centre in a precisely opposite way, so that instead of it stimulating the flow of blood through the gland and otherwise exciting increased activity, the nervous impression arrests the activity, so that less fluid than usual is produced. In a similar way the emotion which produces blushing in one man leads to pallor in another. In the former case the nature of the nervous effect is to permit a greatly increased flow of blood through the vessels of the face, and therefore redness of the surface, in the latter case it diminishes the natural flow, therefore there is less blood in the part and consequently less colour.

The Eyeball is a globular chamber. Its walls consist of several layers. The outermost layer is called the **sclerotic**, is a tough fibrous coat formed for protection and maintaining the shape of the ball, and is thicker behind than in front. This coat is white in appearance, and is the part easily visible to which the phrase "white of the eye" is applied. In the very front of the globe the sclerotic is abruptly transformed into a transparent portion which is circular and which forms a window through which one can see into the interior. This is the **cornea**. The sclerotic is supplied with vessels and nerves, but the cornea, though containing nerves, has no blood-vessels. It is composed of layers of fibres with numerous minute spaces between them, in which little masses of protoplasm lie. The masses send off numerous processes which communicate with one another, so that the substance of the cornea is traversed by fine threads of protoplasm connected with masses. No doubt by this living material, in lieu of vessels, the nourishment of the cornea is maintained without its transparency being interfered with. The visible part of the white of the eye is covered, as already noted, by the delicate membrane, the conjunctiva, reflected

from the inner surface of the lids. This membrane has the structure of mucous membrane, fibrous tissue covered by layers of epithelial cells. But when the conjunctiva reaches the cornea, only its epithelial layers are continued over the cornea. In inflammation of the cornea blood-vessels rapidly shoot into its substance from the conjunctiva around.

Lining the inner surface of the sclerotic is the second coat of the eyeball—the **choroid.** This is essentially the blood-vessel coat of the eyeball.

Fig. 153.—Different Kinds of Pigment Cells from Choroid Coat of the Eye.

It contains a multitude of small arteries and veins whose connecting capillaries form a very close net-work. Connective tissue surrounds the vessels, and in the tissue are branched cells so loaded with colouring matter as to be quite black. Their appearance is shown in Fig. 153. The front part of the choroid terminates about the place where the sclerotic passes into the cornea in a series of ridges, the **ciliary processes.** The circular space thus left in front by the termination of the choroid is occupied by the **iris,** a round curtain, the structure seen through the cornea, differently coloured in different individuals. In its centre is a round hole, the **pupil,** which appears as if it were a black spot. The margin of the iris is connected firmly with the eyeball all round, at the line of junction of the sclerotic and cornea.

The **iris** forms a sort of transverse partition dividing the cavity of the eyeball into two chambers, a small **anterior chamber,** extending from the front part of the iris to the back part of the cornea, filled with the **aqueous humour,** a fluid consisting almost entirely of water with a very small quantity of saline material in solution, and a large **posterior chamber,** filled with **vitreous humour,** a kind of fine transparent, colourless jelly. The iris consists of a framework of connective tissue, and its posterior surface is lined by cells containing pigment which gives the colour to the eye. In its substance are bundles of involuntary muscular fibres, one set being arranged in a ring round the margin of the pupil, the other set radiating from the pupil like the spokes of a wheel. When the circular fibres contract the pupil is made smaller, but if these fibres relax the radiating fibres cause the pupil to dilate more or less widely. The object of this will be seen hereafter.

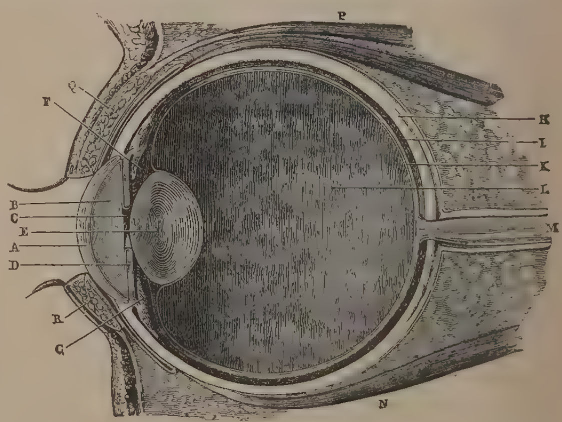


Fig. 154.—Representation of a vertical cut through the Eyeball in its Socket. For description see text.

Just behind the pupil is the **crystalline lens,** resembling a small, very strongly magnifying glass, convex on each side, though more so behind. It is perfectly transparent in the healthy state. The front face of the lens is quite close up to the curtain of the eye, and the vitreous humour, occupying the posterior chamber, is closely in contact with its back face. But the lens is not loosely placed in the eyeball; it is inclosed in a capsule, the **suspensory ligament,** which not only retains it in position, but is capable of altering its shape. For the lens is elastic, its capsule is connected with the ciliary processes, and is kept usually tense, so that the lens is flattened somewhat by the pressure exerted on it. But all round the edge where the cornea, sclerotic, and choroid meet is a ring of involuntary muscular fibres, forming the **ciliary muscle.** When this muscle contracts it pulls forwards the attachment of the suspensory ligament of the lens, whose pressure on the lens is consequently diminished, and the elasticity of the lens causes it at once to bulge forwards, becoming thereby more convex. The

value of this movement will be understood immediately.

Reference to Fig. 154 will render the position of the parts already described more intelligible. It represents the eye lying in its socket, partly covered by the eyelids, and completely opened up by a cut from front to back. In the figure muscles (P, N) of the eyeball are shown, and a meibomian gland opened up (Q, R) is represented in each lid. A is the cornea which, at the place across which the lines from F and G pass, joins the white sclerotic (H). The cornea closes the front of the anterior chamber (B), which is filled with aqueous humour, and the back wall of which is formed by the curtain of the iris (D). In the middle of the back wall is the opening of the pupil (C), through which is seen the lens (E). F and G point to the region of the ciliary muscle and ciliary processes, the forward termination of the choroid coat (F). Behind the lens is the posterior chamber (L), filled with vitreous humour.

Our description is not yet complete, however. The eyeball, at least the posterior chamber, has an innermost lining, called the **retina** (K). The **retina** lines nearly the whole of the inner surface of the posterior chamber, lying on the choroid coat. It is, consequently, with the retina that the vitreous humour is in contact. The retina is the nervous coat of the eye; it really forms the terminal organ (p. 333) of the sense of sight. It is a very thin, soft, white membrane. If the fresh eye of a sheep or ox be opened, and the jelly-like vitreous humour removed, the retina will be seen and easily separated as a pulpy membrane from the dark coloured choroid on which it rests. But it does not separate completely. At one spot it is bound down. This spot is the entrance of the **optic nerve**. The nerve (M) comes from the brain (p. 95) and pierces the eyeball at the back, not quite at the middle, but about $\frac{1}{10}$th of an inch to the inner side, the nose side. The fibres of the nerve are distributed in the retina. The retina does not extend quite to the front limits of the posterior chamber, but stops short, in a scalloped border, the **ora serrata**, a little way behind the ciliary processes.

Though the retina is extremely delicate, its structure is very complicated. If a piece of the retina, representing its whole thickness, is examined under a microscope it shows a structure exhibited in detail in Fig. 155. The part resting on the choroid coat consists of six-sided granular nucleated cells filled with colouring matter (Fig. 153). Outside of that is a layer called **Jacob's membrane**, containing bodies termed **rods and cones.** To this succeeds a layer of nuclear bodies developed in fibres continued

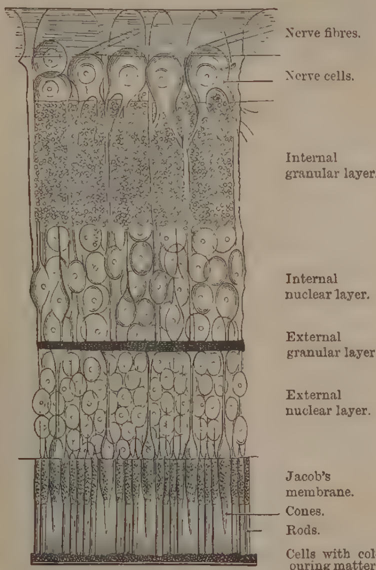


Fig. 155.—The Microscopic Structure of the Retina.

from the rods and cones. Outside of these a granular layer, and other nuclear bodies, &c., as represented in Fig. 155. The two layers nearest the surface of the retina, nearest the vitreous humour, therefore, are a layer of nerve-cells and nerve-fibres. In the retina vessels ramify in the region between the inner granular layer and the surface next the vitreous. The vessels are branches of the artery that enters in the substance of the optic nerve.

At the entrance of the optic nerve the retina contains no rods or cones. In the retina at a point exactly in the middle of the back wall, therefore directly opposite the centre of the pupil, (about $\frac{1}{10}$th of an inch to the outer side of the optic nerve entrance), there is a yellowish spot of an oval shape, the **macula lutea**, or **yellow spot** of Soemmering, which exhibits a central depression. At this part the retina is very thin, all the layers being very much diminished in thickness, except that of the rods and cones, the layer of nerve-fibres being absent. In the layer of rods and cones marked differences from other parts also exist, for rods are scarce and cones are very close and numerous.

The rods and cones are to be regarded as the peculiar modes of termination of the nervous filaments in the eye, just as the taste buds are

the modes of termination of the nerve of taste in the tongue (p. 337), just as the touch-bodies are the terminations of the nerves in the skin (p. 335), and just as epithelial cells of a peculiar shape form the terminations of the nerves of smell in the nostrils.

THE SENSE OF SIGHT.

The Perception of Light.—The agent that excites the terminations of the nerve-fibres in the retina is light. The sensation of light is produced in the brain by impulses reaching certain nerve-centres and coming along the optic nerves. These impulses are, in ordinary circumstances, sent along the optic nerves by the retina, and are communicated to the retina by the vibrations of ether which are held to be the physical cause of light. But any excitement of the optic nerve, if it be passed on to the brain, will produce a sensation of light. Thus electrical stimulation of the optic nerve will do so, because it, equally with the usual stimulus of light, sets up changes in the brain cells, which occasion the sensation. Mechanical stimulation, of which the commonest form is "a blow on the eye," will also excite the nerve and produce sensations of light. It is the terminations of the nerve-fibres —the rods and cones, not the fibres of the nerve themselves, that are excited by light, for light falling directly on the optic nerve alone has no effect, while the feeblest glimmer of light will excite the retina and lead to a luminous impression.

The whole surface of the back of the eye is not, however, equally sensitive. There is, indeed, a spot, where the optic nerve enters the globe, completely insensitive to light. It is, therefore, called the "**blind spot.**" Light falling upon it produces no stimulus. At this point there are no rods and cones, and in this fact is one reason for the belief that the rods and cones are the agents by whose aid the waves of light become transformed into the stimulus of a sensation. A simple experiment proves this. Shut the left eye, and hold the thumbs of each hand side by side directly in front of the eye, with a good light falling upon them, and at the distance one would hold a newspaper in reading. Fix the right eye on the nail of the *left* thumb, and then move the *right* slowly away to the side. Though the eye is steadily regarding the left thumb both are seen, when the right is moved only an inch or so, but when the right thumb has been moved off several inches, the end joint disappears from view, though the shut hand is still visible, and when it has been moved a little further the whole right thumb is again visible to the eye, still fixed on the left thumb. The explanation is that at a particular distance the rays of light from the end of the thumb fall on the blind spot, and give rise to no sensation, and when the hand is moved to one side or other of this place the rays fall on the retina on one side or other of the optic nerve entrance and so produce the sensation. If when the thumb has disappeared the hand be moved in any direction, forwards or backwards, the thumb will again come into view, for the rays will be made to fall on the retina. The same thing may be shown in another way. Shut the left eye and fix the right on the small letter a (Fig. 156).

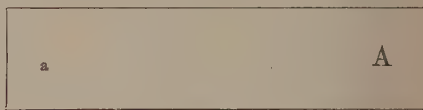


Fig. 156.—To show the "blind spot."

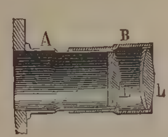
Then move the book near to or farther from the eye. In one position the large letter A disappears from view, in others both are visible.

The yellow spot (p. 341), directly in the centre of the back of the eye, is the most sensitive part of the retina to light. Objects are most distinctly seen when the eyes are so directed towards them that light from them falls on the yellow spot. In this spot cones are specially numerous, there are no fibres of the optic nerve, and the other layers of the retina are very thin. This is another reason for the belief that the rods and cones are the true essentials of the terminal organ of vision. In looking at any extended object the eyes are rapidly moved in various directions, so that its various parts are brought in line with the yellow spot. As a result of a fusion of all the different impressions received, which fusion is effected in the brain, the person judges of the appearance of the object as a whole. This grouping of impressions we are often unconscious of. It is done so rapidly and so habitually that we are apt to believe that we see with equal distinctness the whole of an extended object at once. In reading a printed page we know the eye moves so as to perceive one word after another in the printed line, and if we fix the eye on the centre of the line the ends will be indistinct. It is because we move the eyes so rapidly, and because we learn to take notice only of the distinct impressions, due to rays of light falling

on the yellow spot, that we are quite unconscious of the existence of a blind spot.

The stimulation of the retina does not pass off immediately the cause ceases to operate. Its effect lasts for a distinct period, about the ⅛th of a second. If, therefore, two impressions follow one another at a less interval they appear as continuous, since the effect of the one has not passed off before the other is produced. If, in a series of flashes, one follows another at less than the interval named, the impression of a continuous flash will be produced. It is thus that a string, glowing red-hot at one end, and rapidly whirled round, produces the impression of a circle of light. This fact is taken advantage of in the construction of the wheel of life. Here a set of pictures is produced on a circular band of paper, which is set in a revolving wheel. The pictures represent a man, let us say, in the different positions he would be in, one instant after another, during the act of walking, for example. One picture follows another in its proper order, and when the wheel is rapidly revolved the appearance of the man walking is produced.

The Perception of Objects.—Were the retina the complete terminal apparatus of vision all that one could be conscious of would be a sensation of light whenever the retina was stimulated, but we could have no definite knowledge of the object from which the light proceeded. Photographers obtain a picture of a person by the use of a plate of glass on which is a film sensitive to light. This sensitive plate is placed in a box or camera, facing the person. But were the camera a simple box with a hole in front through which the light could fall on the plate behind, the result would be a uniform darkening of the film from the exposure to light and no picture would be produced. What the photographer desires is to throw on the plate an image of the person in light and shade. The parts of the sensitive film on which the light portions of the image fall are strongly acted on, and the parts on which the shadows fall are feebly acted on, and more or less feebly as the shadows are deep or slight. The sensitive plate is thus unequally acted on, and when the photographer has submitted it to the action of certain chemical solutions the film is left thick and dark where the strong light fell, but thinner and more or less transparent in the places corresponding to the shadows. If then he holds his plate up to the light and looks through it, he sees in light and shadow an image of the person who sat before the camera. But to obtain this there must be certain definite parts of the sensitive plate corresponding to certain parts of the person. Thus if the light is shining strongly on one side of the person's face, the sensitive plate must receive the rays reflected from that part of the face, and these rays must not be diffused over the whole plate, but made to fall on a part of the plate corresponding accurately in outline and in proportionate size to the part from which they have proceeded. So it must be with the rest of the figure. On the plate there must be parts corresponding to the parts of the person to be photographed. It is the same in vision. If not merely a general impression of light is to be obtained, but a definite knowledge of things, then on the retina there must be distinct luminous impressions, distinct regions of light and shadow corresponding to the lights and shadows of the object from which rays of light are proceeding to the eye. In short, we cannot see in absolute darkness, we see only when light enters the eye, and we see definite things only when rays of light fall on them and are by them reflected into the eye. If all objects reflected



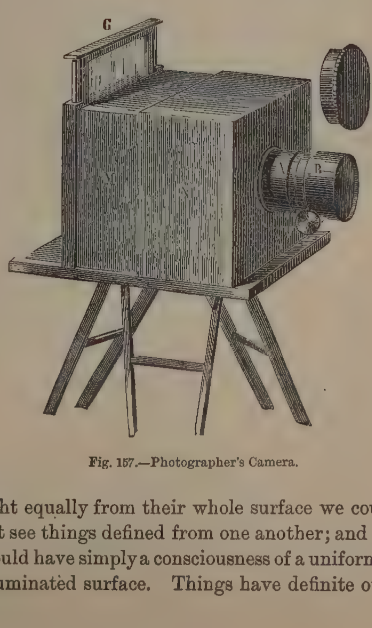


Fig. 157.—Photographer's Camera.

light equally from their whole surface we could not see things defined from one another; and we would have simply a consciousness of a uniformly illuminated surface. Things have definite out-

lines, and forms, because light is unequally reflected from different parts of their surface, the illuminated object being mapped out by the shadow that surrounds it. It is only, then, when such illumination and shadow are accurately reproduced on a sensitive photographic plate that an image of a person or object is obtained, and only when accurately reproduced on the sensitive coat of the eye that we can see things distinctly. How then is this accurate reproduction of light and shadow obtained? Let us examine the photographer's apparatus, for in it is an accurate representation of the eye.

The photographic camera is a box (M N, Fig. 157), the inner surface of which is painted a dull black, and which is light-tight. In front is an opening into which is screwed a brass tube (A B) fitted with a series of convex lenses, shown in the upper part of the figure (E L). A screw (V) enables the tube containing the lenses to be worked backwards or forwards in an outer case. The box is closed at the back by a ground-glass plate (G), capable of being removed. No light enters the box except through the opening in front (which may be closed by a cap), and it must pass through the lenses on its way.

The effect of a convex lens is exhibited in Fig. 158. It brings rays of light passing through

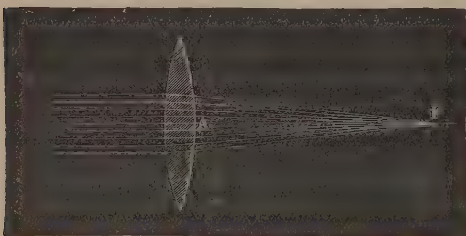


Fig. 158.—Effect of a Convex Lens.

it to a point or focus (F) by refracting or bending them out of their course. Now suppose that the object from which the light is reflected is an arrow, as in Fig. 159. The rays of light from the point of the arrow (A) are acted on by the lens and brought to a focus at a, the rays from the other end of the arrow are focussed by the lens at b, and rays from every other point of the candle are focussed at corresponding points between a and b, so that rays from every point of A B have corresponding points in the line $a\,b$. In short, an image of A B is produced at $a\,b$ through the agency of the convex lens, but the image is upside down, because, as we see, a is the image of A, and b of B. Now if at $a\,b$ a screen were placed, and if all light except that passing through the lens

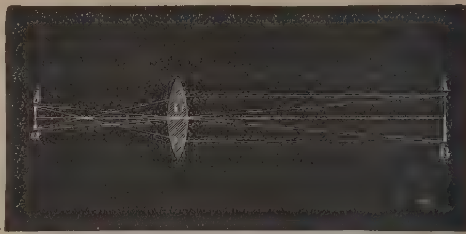


Fig. 159.—Formation of an Image by a Convex Lens.

were prevented falling on the screen, a bright distinct image of the arrow would be seen, but smaller than the real object and upside down. The conditions would be accurately fulfilled if the screen were on the back wall of a black box which had an opening in front in which was fixed the lens. But this is just a camera with its ground-glass plate as screen. The inside of the box is blackened to prevent reflection of light which would mar the distinctness of the image. Now from Fig. 159 it will be evident that if A B were brought nearer to the lens, its image $a\,b$ would not be found in the same place. It would be further removed. The screen would require to be moved back a bit. Suppose the screen were immovable, the lens might be altered in position so as to bring the focus once more on to the screen. If the lens could not be moved, nor the screen, the new position of AB would cause its image to fall behind the screen. If another lens were placed in front or behind the original one its action would be strengthened, the rays would be brought to a focus sooner, and if the added lens had the proper degree of convexity (of thickness in the middle) the image would be brought forward so as to make it once more fall on the screen. Now in a photographer's camera the screw which moves the lenses backwards or forwards in their outer tube is for the purpose of bringing the focus always on the ground-glass plate. Usually also the box is made so that it can be lengthened or shortened to effect the same purpose, for the lenses always remain the same. Another thing remains to be noticed about the photographer's camera. Lenses focus more quickly rays of light passing through them near the circumference than those passing through the centre. Both sets of rays are not focussed at the same point. If the rays come

from an object, the image produced is not definite, because all the rays of light are not equally focussed. Now in a camera this is corrected by the use of a stop or diaphragm. It consists of a plate of metal with a hole in the centre. This is passed through a slit in the metal tube between the lenses. It cuts off the outside rays, the centre ones only passing. The holes are made of various sizes to suit the amount of light. By means of the stop an element of confusion is removed and the image made very distinct.

Now if this description of a photographer's camera be applied to Fig. 154 it will be evident how accurately it represents the purposes of the eyeball. The eyeball is a chamber with compact walls into which light can pass only through a clear portion in front (the cornea). Like the camera the eyeball has a dark coat to prevent reflection of light, the dark choroid. Towards the front is a lens—the crystalline lens—through which all rays of light that enter the eye must pass. The lens focusses the rays as any ordinary lens would do. But the action of the lens is aided. There are several refractive substances forming the eye. The cornea refracts slightly, so also does the aqueous humour filling the anterior chamber, and the vitreous humour filling the posterior chamber does so to a greater extent than either cornea or aqueous humour. Thus the moment rays of light enter the eye they begin to be bent out of their course, and the result of the action of the lens, aided by the cornea and aqueous and vitreous humours, is that rays of light that are parallel when they fall upon the eye are brought to a focus on the back wall. If then an object is a long distance off, rays of light proceeding from it and falling on the eye are brought to a focus on the back wall of the eye, and there will be produced a small image of the object *upside down* (Fig. 160). Suppose the object is brought near, then, as we have seen with a lens, the image would fall beyond the wall of the eyeball. To secure that it fall on the wall exactly, one of three things is necessary, as we have seen, the wall must be moved further back, or the lens must be capable of movement, or there must be some way of increasing the focussing power of the lens, so that the rays are sooner brought to a focus, and thus made, once more, to fall on the wall. In the eye it is the convexity of the lens that is altered, and by this means the eye is capable of accommodating itself to different distances, as it is phrased.

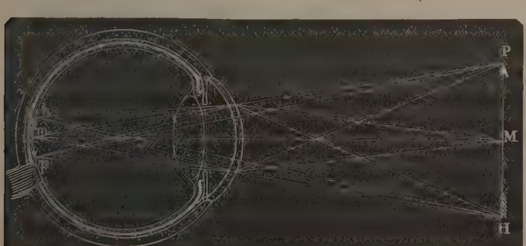


Fig. 160.—Formation of Image on the back of the Eyeball.

Rays of light proceed from the points P, M, H of the arrow and are focussed by the lens and humours of the eye to form an image, p, m, h, which is smaller than the object and inverted.

Accommodation of the Eye to different distances. We are continually moving our eyes from object to object, now looking at something at a distance, now at something near, and again at something far off. To see each thing distinctly the eye must be capable of altering itself with great precision and rapidity to suit the varying distances. The lens is a very elastic body, as stated on p. 340, and is confined within a capsule which presses upon it, and flattens it somewhat. But the pressure of the capsule may be relaxed by contraction of the ciliary muscle (p. 340), so that the lens bulges forwards and becomes more convex. When we look at a near object the ciliary muscle contracts, the capsule relaxes, the lens bulges forwards, the rays of light are thereby more refracted and the image of the object is distinctly produced on the back of the eyeball. When the object is nearer, the ciliary muscle contracts more, and the lens becomes still more convex. When the object is far away, if the lens were to remain as before, the image would be formed in front of the back of the eyeball, and, therefore, the ciliary muscle relaxes, the capsule tightens, the lens is flattened slightly, refracts less strongly, and the image is formed on the back wall as before.

Normal or regular **Sight** exists when the degree of convexity of the lens and the length of the eye are such that rays of light coming from a distance are brought to a focus on the retina—the lining of the back of the eye—*without any effort of the eye*, the eye remaining at rest. Practically all objects at a distance of about 70 yards and upwards from the eye require no effort of accommodation. This distance from the eye is the far point at which the need of accommodation

ceases, and it has been called the *punctum remotum*, or far point. As soon as an object comes nearer than that, the lens must begin to become more convex, and the nearer the object comes the more does the lens increase in convexity by the contraction of the ciliary muscle, till the object is so near that every effort is made to produce greater contraction and thereby greater convexity, and a sense of straining is experienced. A point is at last reached so near to the eye that no further accommodation can be effected, and, if the object is brought nearer, it is no longer distinctly seen. This point is the *punctum proximum* or *near point*, and for the ordinary eye the distance is about six inches. In other words, from an object distant 75 yards and upwards from the eye reflected rays of light falling upon the eye, and passing through its lens, humours, &c., come naturally to a focus on the retina and form an image there, without any effort of the eye. Rays from an object any nearer than that would be focussed behind the eye were no effort made, but by the arrangements for accommodation the lens becomes more convex and the rays are focussed sooner, so that they again fall on the retina. As the body comes nearer and nearer the effort on the part of the eye to focus the rays becomes greater and greater till no greater effort can be put forth, and if the body be nearer than six inches the effort is not sufficient, the lens cannot become convex enough, and thus the rays are no longer brought to a focus on the retina, and in consequence the body can no longer be distinctly seen.

Long-sight (*Hypermetropia*).—If the arrangements necessary to secure distinct vision when a person looks at objects at varying distances from the eye be understood, the defects of the eye, termed long-sight and short-sight, will be readily comprehended. We have seen that in ordinary conditions of the eye, rays of light from distant objects form a picture on the retina without any effort on the part of the eye. Now suppose the distance between the back wall of the eye and the front is less than usual, other things being usual, rays of light from far-off bodies will reach their focus not on the retina, as they ought to, but behind it, because the retina is not so far back as it ought to be. (Refer to Fig. 161.) If the difference from the normal be slight, the person is able to correct it by a slight effort of accommodation. By this slight effort the lens becomes more convex, brings the rays sooner to a focus, and thus brings the picture forwards so as to make it fall on the retina, when the object is distinctly seen. The effort required may be so slight that for a long time the person is unaware of it. But the meaning

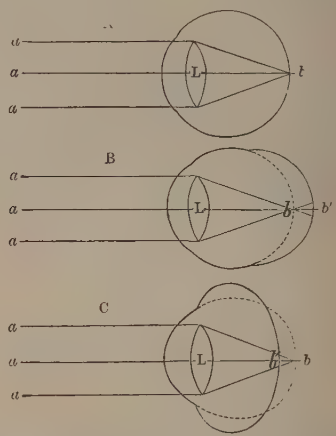


Fig. 161.—A, Ordinary Eye, rays of light *a a* from a distance coming through the lens L to a point *b* on the retina. B, Short-sighted Eye, rays from a distance coming to a point *b in front* of the retina *b'*. C, Long-sighted Eye, rays from a distance coming to a point *b behind* the retina *b'*. L is the lens in each case.

of the condition is, that even when the person is looking at far-distant things, which in ordinary circumstances he should see distinctly without any movement of the lens, even when looking at these far-off things his eyes are not at rest, but require to focus to make the image fall on the retina. As the object comes nearer the amount of focussing required becomes greater, and the power of accommodating the eye to see distant objects, having begun sooner than is usual, is sooner exhausted. That is, the eye becomes unable to focus any further before the object has come so near the eye as is usual. Thus a person with long-sight is unable to read a letter or newspaper, let us say, when it is held the ordinary distance from the eye, because his focussing power has failed sooner than is customary. He, therefore, holds the paper or letter farther off from his eye than ordinarily is done. The "near point" is farther away from the eye than in ordinary sight. The defect is called "long-sight" on this account. The remedy is evident. Suppose it is at twelve inches from the eye that the power of the lens to become more convex fails, by placing in front of the eye a spectacle whose surface is convex—rounded—the lens is aided, the focus of the rays is brought forward, and the person can now hold his letter or paper nearer and yet see distinctly. (Refer to B. of this section.)

The accommodation of the eyes of a long-sighted person is never at rest. The result is that in time a feeling of strain and soreness is produced, and the eyes become red and watery, especially when the person reads, writes, sews, or performs any fine work, since, the nearer the object is, the more effort is required to see it distinctly.

Short-sight (*Myopia*) is the opposite condition to the former. The distance between the back and front of the eye is greater than usual. When the person looks at distant objects, the focus does not fall on the retina as in ordinary sight, nor yet behind the retina as in long-sight, where the distance is less than usual, but it falls in front of the retina. (Fig. 161, c.) It is plain that the person can do nothing to correct this. His eyes are at rest, and yet the focus is in front of the retina. Any effort of accommodation would make things worse, by making the lens more convex, and bringing the image still farther forwards. If the lens could be flattened so that the rays were not brought to a focus so soon, distinct vision would result, but there are no arrangements for doing this. The eyes are at rest, and in this state the lens has its least degree of forward curve. Now as the object looked at comes nearer and nearer the focus gradually passes back till at length it falls on the retina, and the person then sees the object distinctly. Thus a short-sighted person cannot see persons or things distinctly at a distance. Moreover, a short-sighted person sees distinctly, and without any accommodation by his eyes, that is, his eyes being at rest, an object at the distance for which a person with ordinary sight requires to focus strongly. That is to say, the short-sighted person does not require to bring into play the arrangements for accommodation so soon as the person with ordinary sight, and thus the accommodation of the person with ordinary sight is exhausted before that of the short-sighted person. Thus, when the ordinary individual has brought printed matter so near his eyes that if he holds it any nearer it is no longer distinct, the short-sighted person can bring it much nearer and still see it distinctly. Indeed to see it distinctly he requires to hold it nearer than the ordinary reading distance. On this account the defect is called "short-sight." It is thus evident that the short-sighted person cannot by any means see things at a distance distinctly, because the picture does not fall on the back wall of the eyeball; on the other hand he sees things very much nearer than usual. To correct this some arrangement is required which will prevent the rays of light coming so soon to a focus, by which means the image will be produced further back and made to fall on the retina. A concave spectacle—one hollow on the surface—does this, for it slightly disperses the rays, and they are brought to a point later than they would otherwise be. (Refer to B. of this section.)

The Movements of the Eyeball.—The eyeball is controlled by a set of six small muscles, which, with one exception, are attached to the back part of the cavity in which the eye rests. The muscles pass forwards and are connected by thin flat tendons to the outer coat of the ball, a short distance behind the clear part of the eye—the cornea. Four of these muscles run a straight course, and are called **recti muscles** (Latin *rectus*, straight). One is attached in the middle line above, another below, and one to each side of the eyeball. They are, therefore, called superior, inferior, internal and external. Acting alone one would turn the eye upwards, another downwards, the third inwards, the last outwards. The other two muscles bend in their course, and are called **oblique muscles.** One arises behind in common with the four straight muscles, and passes to the front towards the inner angle of the socket, there it ends in a round tendon and passes over a tendinous pulley. From the pulley it changes its course, proceeds over the eyeball slightly backwards and becomes attached to the ball at its outer side. When it contracts, acting round the pulley, it rolls the ball. Since it proceeds over the eye it is called the **superior oblique muscle.** The other oblique muscle is below—**inferior oblique.** It springs from the lower part of the inner angle of the socket and passes below the ball towards its outer side where it is attached. When it contracts it also rolls the eyeball, but in an opposite direction to the superior oblique. These oblique muscles do not act alone, but in association with one or other of the straight muscles. In combination they produce the varied movements which the eyeball can so freely perform.

As a rule both eyes are moved at the same time in the same direction, so as to regard the same object. When one muscle becomes paralysed so that the eyeball cannot be turned in that direction, the two eyes no longer act together, when the person seeks to look that way. The sound eye is turned far enough, the other fails to go round. Squinting is produced, and

the particular object looked at is seen double. As soon as the eyes are turned in other directions, they again act together, the squint disappears and the vision is single. (Refer to **Double Vision**, p. 350.)

The Information gained by the Eyes.—It may be well to state here briefly the substance of the foregoing paragraphs. The eye is to be regarded as the peculiar form of ending of the optic nerve, designed to be affected only by light, and so excited by light as to send on to the brain an impression which there gives rise to a sensation of light. It is supplied with a series of structures that act as convex lenses, which so focus rays of light, passing through them from external objects, as to form small images of these objects on the retina, the nervous coat that lines the inner surface of the back chamber of the eyeball. Now the first thing to notice is, that it is this image on the retina that produces the sensation of seeing something, and yet we are not conscious of the image on the retina but only of the outward thing from which the rays of light proceed. This is difficult to understand. It is doubtless the result of education. We learn that the things we see are the result of impressions reaching us from the outside, and we refer the object from which the impressions reach us outwards in the direction of the straight lines in which the rays of light fall upon the eye. Thus, it is related of a patient, who was blind from his birth owing to cataract, that when sight was restored by an operation, performed by the English surgeon Cheselden, he thought all objects he saw touched his eyes. His other senses corrected his mistake. He found when he put his hand up that the objects did not touch his eyes, that he had to walk towards them in order to touch them, &c. Thus he trained his eyes by means of other senses, and in other ways, to appreciate the distance from him of the objects he saw. Again, the brain of the man suffering from delirium tremens is disturbed and excited by what he has drunk. The seeing centre in the brain is aroused by the stimulant and perverted by it, and he becomes conscious of images so produced, and believes them to represent actual existences. The creatures that leer at him, and crawl over him, and dance before him, are the creations of his excited brain, but his judgment is also perverted, and he is unable to perceive that they have no real objects corresponding to them in the external world. Again, when pressure is exerted on the eyeball, or when a sudden blow is received on the eyes, the nervous apparatus of vision is excited and colours or bright sparks (called **phosphenes**) are seen, which only experience teaches to be due to internal disturbances. The production of what are called **Purkinge's figures** is another example of the same thing. If a person goes into a dark room with a lighted candle, and, facing a blank plain-coloured wall, holds the candle to the side of the head, moving it up and down, the appearance of branching lines will be seen on the wall. These are shadows of the blood-vessels of the retina (p. 341). The sensitive portion of the retina (the layer of rods and cones) is behind the blood-vessel layer, and thus the lines of vessels intercept the light passing in at the extreme side of the eye, the shadows produced appearing to the person to be something outside. Then it is well known that minute floating bodies in the humours of the eye produce shadows which to the person seem to float across his vision in space. These are called **muscæ volitantes**. It is then only by a process of education, in which the various senses take part, that a person learns to judge of the actual existence of an outward object corresponding to his sensation. It may be remarked that a similar explanation applies to **hallucinations**. This is the term given to things a person seems to see for which there is nothing externally to account. There are undoubted cases on record where an individual has seen a person or thing in the immediate neighbourhood, and by going up to the place has assured himself that nothing but simply space existed there. Sir David Brewster gives a case, in his *Natural Magic*, of a lady who on entering the drawing-room saw her husband standing on the hearth-rug with his back to the fire. She addressed him and sat down in a chair within two feet of the figure. After she had again spoken, the figure moved off to the window and then disappeared. Frequently afterwards she had similar experiences, seeing other persons and things, in the presence, on one occasion, of her husband, who assured her that the cat she saw sitting on the rug at his feet had no actual existence. She herself had the courage more than once to convince herself that the appearance was a deception by sitting down on the chair on which she saw someone sitting, when the appearances vanished. In these cases changes were excited in the nervous apparatus of vision not due to any outward existence, though as a rule only produced by such, and the lady was consequently

for the time deceived, until she had corrected her sensations by other means.

Another thing to be noticed is that the image on the retina is upside down, and yet we see things in their upright position. When we direct our eyes towards a particular object rays of light pass into the eye not only from that object but from other parts in its immediate surrounding, and we become conscious not only of the particular object we are looking at but of a region round about it. This region is called the **visual field** or **field of vision**. Now rays of light coming from the left of the field of vision fall on the right side of the retina, rays from the upper part of the field fall on the lower part of the retina, rays from the lower part of the field on the upper part of the retina, and so on. We refer the image on the lower part of the retina in the direction from which the rays come, that is, towards the upper part of the field of vision. Moreover we interpret by means of touch, for, to reach with the hand the part of the object whose image is on the lower part of the retina, we must raise the hand, and to touch the part of the object whose image falls on the right side of the retina we must pass the hand to the left side, and so on. Thus though the image is upside down on the retina, we see the object upright.

The **estimate of size** given by the eyes depends on the angle formed by the rays of light before crossing in the eye. This is explained by Fig. 162. From the object PAH, rays P*p*, H*h* pass to the eye. At O they form an angle POH. This is the visual angle, the angle under which PAH is seen. PAH forms an image *ph* on the retina, and its apparent size is dependent upon the angle at O. But the lines P′BH′ and P″CH″ are seen under the same visual angle, and will,

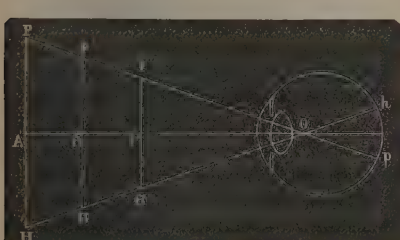


Fig. 162.—The Visual Angle.

therefore, have the same apparent size, and form images of the same size on the retina. To this impression, however, there remains to be added the idea of distance. We know that as objects pass farther and farther away from us they appear smaller and smaller, and as they approach they become larger. If, therefore, an object at a great distance off appears as large as an object very near to us, we judge the far-off object to be much more extensive than the near one.

Our **appreciation of distance** is guided to a large extent by the clearness with which the object looked at is perceived and its details made out. If the atmosphere be very clear, mountains at a distance appear nearer than they do when the atmosphere is hazy. An artist gives an impression of distance to the objects in the background of his picture by the want of distinctness of their outline and detail. It is very difficult, however, to judge absolutely of distance. Between us and a distant object a great many other objects intervene, whose distance from us we can more readily estimate. We thus guide ourselves in forming an idea of the distance of the far-off object by the others which are between, and which afford us something to measure by. Thus everyone knows the errors easily made by sailors at sea in judging of the distance between their ship and another, because of the absence of anything between to aid the vision.

For various reasons, therefore, judgments

Fig. 163.—Judgment of Distance.

formed by vision of the real size and distance of things are not too reliable. A good illustration is given in Fig. 163. The distance between A and B seems greater than the distance between B and C, and yet it is the same, the apparent increased space between A and B being due to the markings between. For the same reason, of two squares absolutely identical in size, one marked with alternately clear and dark crossbands, and the other with alternately clear and dark upright markings, the former will appear broader and the latter higher than the other. Thus a short stout person whose dress is cross-striped or made with flounces appears stouter than she really is, and a tall woman whose dress has upright markings or folds that run up and down exaggerates her length. Consequently a stout person who wants to increase her apparent height and diminish her apparent stoutness should wear dresses striped or folded up and down, and a tall person who wishes to diminish her apparent tallness and to appear stouter should wear cross-marked or folded dresses.

Single Vision with Two Eyes. When we look at an object with both eyes, it appears under ordinary circumstances as a single object. Two images of the object are produced, however, one on the sensitive coat (retina) of each eye, though we are not conscious of two images. If now a finger be pressed strongly on one eyeball so as slightly to push it to one side, the object will appear double; when the pressure is removed the object is again single. It seems, therefore, that single vision with two eyes is produced when the image of an object falls on the corresponding part of each retina. If one eye be so displaced that the image falls on a part of its retina that does not correspond to that of the other eye, then the object appears double—**double vision**, as it is called, is produced. In looking from one object to another the eyes are moved together in harmony with one another, and single vision is constantly secured. If, however, a person suffers from paralysis of one of the muscles of one eyeball, then it is evident that when the eyeballs are moved in a particular direction the paralysed muscle will be unable to contract, will be unable to pull the eyeball round in that special direction, and thus, while the eyeball, whose muscles are all sound, is properly directed to the object, the other one cannot be sufficiently brought round, the image of the object will not fall on corresponding points of the two eyeballs, and double vision will result. Since only one muscle is affected, the eyeball can be moved quite freely in every direction but one, and thus in all other directions single vision will be produced, because in all directions but one both eyeballs will act together. Persons who squint would also "see double" were it not that they accustom themselves to use only the straight eye, and speedily become altogether unconscious of the image on the squinting eye.

Single vision with two eyes, that is **binocular vision**, enables us to judge of the solidity of objects looked at. The image that falls on each eye is not absolutely the same, because each eye regards the object from a very slightly different point of view. The two images, differing so little from one another, are fused together in our consciousness; but the result of the slight difference is to give us a particular impression which experience has taught us is due to the object being not flat but raised—we have, that is, the impression of a solid body. This may be illustrated by a very simple experiment. Fig. 164 shows two views of a cube; the view on the right hand presents the appearance that would be perceived suppose a cube were looked at by the right eye, while on the left hand is the appearance of the cube to the left eye, the position of the person not

Fig. 164.—Stereoscopic Views.

being changed. Now let one take a card about 10 inches long and hold it between the two views, let the person rest his forehead on the upper end of the card and look on the figure, so that the left eye sees only the left view and the right eye sees only the right view; with a slight converging of the eyes only one cube is seen, but it is neither the right-hand nor left-hand view, but a view produced by an overlapping of the two, and the cube stands out from the paper as if it were actually a solid body.

This is the principle of the **stereoscope**, Fig. 165. It is a box divided into two sides by a

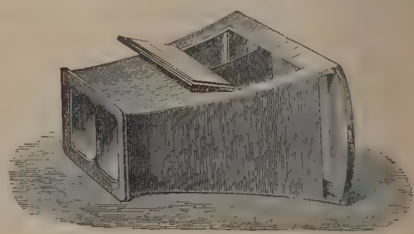


Fig. 165.—The Stereoscope.

thin partition down the centre. In the bottom of the box is placed a card on which are pasted two photographs of the same thing. Each photograph, however, has been taken from a slightly different point of view, so slightly different that, without careful examination, one would conclude they were both absolutely the same photographs. The views are of such a size that each one extends across the space in the bottom of its compartment, and the central partition accurately separates the two. At the opposite end of the box are two lenses, so placed that when the box is held up to the eyes each eye looks through one lens. Looking through the glasses each eye sees a photograph, slightly magnified. The lenses are of such a shape that they cause a slight displacement of the pictures, so that the images fall on corresponding points of the two eyes. The two images are fused together, and one becomes con-

scious of only one picture, in which the objects stand out in relief, just as they would appear were one looking at the actual objects themselves.

Colour. Ordinary sunlight appears to be compounded of seven different colours: red, orange, yellow, green, blue, indigo, and violet. If a wedge-shaped piece of crystal—a prism—be held up between the sunlight and the eye, these various colours will be seen, because the prism separates the white light into its constituent colours. The band of the different colours produced in this way is called a spectrum—the spectrum of sunlight. The rainbow is such a spectrum. The same thing can be shown in another way. If the seven colours be painted

Fig. 166.—Rotating Disc of Sir Isaac Newton for mixing Colours.

on a wheel as indicated on Fig. 166, and in proper proportion, and the wheel be turned on a pivot through its centre with great rapidity, the eye will not perceive any colour at all, but the wheel will appear a dull white. If, however, one of the seven colours be omitted, the revolving wheel will be no longer white. The six remaining colours will still be fused together, so as to give the impression of one colour—the result of the union of the six.

Now bodies appear variously coloured because of their behaviour to white light. Some bodies held up between the light and the eye permit all the rays to pass through, and therefore appear without colour, other bodies do not permit all the rays to pass, they intercept some. Thus one body keeps back all rays but the red; they alone pass through, and thus the object appears red. Another body keeps back all the rays but the yellow and some of the red, and it appears to be orange. A third body permits only the violet rays of white light to pass, and it, therefore, appears violet, and so on. Again another class of bodies do not permit rays to pass through them, but they reflect rays. Their apparent colour depends upon whether they reflect white light unchanged, or whether they reflect only some of the seven different rays of white light and retain or absorb others. A body that reflects the white light unchanged appears white, a body that does not reflect it at all, but absorbs it, appears black. One body absorbs all rays of white light except red, these it reflects and it appears red in consequence. If you throw a beam of red light on such a body, say a piece of red ribbon, it reflects the rays and appears brilliantly red. But throw a ray of yellow light on the red ribbon, it does not reflect but absorbs yellow light; in consequence it appears no longer bright coloured, but almost black. An orange ribbon reflects partly red and partly yellow rays of white light, the others it retains, and it therefore appears orange, that is a blend of red and yellow.

It has been said that the seven different colours of the spectrum, painted in certain proportions on a wheel which is turned with great rapidity, will produce the impression of white. It has been found that these seven separate colours are not required, but that the impression of white can be produced by three colours only, viz.:—

Red.
Green.
Violet.

These three painted in proper proportion on a wheel will give the impression of white. Moreover, all the seven colours of the rainbow can be produced by varying the proportion of these three colours. On this account they are called the **fundamental colours**.

Complementary Colours are not to be confounded with the fundamental. There are certain pairs of colours which when blended produce a sensation of white. Thus:—

Red	and	Blue-Green	produce	White.
Orange	,,	Blue	,,	,,
Yellow	,,	Indigo-Blue	,,	,,
Green-Yellow	,,	Violet	,,	,,
Green	,,	Purple	,,	,,

That is to say, given red, the other colour required to produced white is bluish-green; or given bluish-green, the other colour required is red, and so on. These colours are therefore said to be "complementary" to each other, because they together produce white.

Here a mistake must be guarded against. It must not be supposed that it is meant that

a mixture of paints of these colours will produce a white paint. A red powder and a bluish-green powder will not produce a white one, as everyone knows, nor the mixture of red and bluish-green liquids. But if, at the same instant, the eye be affected by red and bluish-green light, the sensation is not of either colour, but of white. It is the sensation that must be mixed, so to speak, and the mixed sensation is not produced by a mixture of the differently coloured powders or liquids.

The Perception of Colour by the eye is explained by a theory first proposed by Thomas Young, and afterwards more fully worked out by the German professor, Helmholtz. According to that theory there are in the eye three sets of nerve-fibres capable of being excited by the fundamental colours (see above). One set is excited by red light, another by green, and another by violet. Just as the different colours of the rainbow may be produced by various proportions of these three colours, so may different sensations of colour be produced by the excitement of these three sets of nerve-fibres in different amounts. Thus, when all the three sets of fibres are nearly equally excited, there is a sensation of white. Red light will strongly arouse the nerve-fibres sensitive to red, and will barely affect the other two. Yellow light will moderately excite the fibres sensitive to red and green, and not those sensitive to yellow, and the result is not a sensation of red or green, but of yellow. Blue light excites moderately the fibres sensitive to green and violet, and barely affects those sensitive to red, and there is a sensation of blue. This theory would account for colour-blindness. Thus, if the fibres that ought to be sensitive to red, for some reason or other did not respond at all, the person would be unable to perceive red. (Colour-blindness is considered at length in the second part of this section.)

After-images are also explained by the theory of colour and its relation to the perception of colour. If, on awaking in the morning, we look *for an instant* towards a window through which bright sunlight is streaming, and then turn away the head and shut the eyes, we are aware of an image of the window, in which the panes appear white and the sashes, &c., dark, as they appeared when actually looking at them. This is a **positive after-image**, and is due to the fact that, the sensitive coat of the eye being highly excitable by the long rest of the night, the effect of the stimulus of the light lasts even after the exciting cause has ceased to operate. If, however, we gaze *for a time* at the window and then look away and shut the eyes, or look towards a dark part of the room, we see an image in which the light and dark parts are reversed, the panes being dark and the sashes white. This is a **negative after-image**. It is due to the sensitive coat of the eye being fatigued in certain parts. The parts corresponding to the panes, on which the strong light fell, are exhausted and appear dark, while the parts corresponding to the sashes, on which the light did not fall, are still unexhausted and therefore appear light. In a short time the retina recovers and the experiment may be repeated.

Now, suppose we look fixedly for a short time at a white sheet of paper on which is a red spot, a bright light falling on the paper, and then turn the eyes to a plain white sheet of paper or to a white wall, an image of the spot will appear to float before the eyes, but it will not be a red image but bluish-green. The explanation of this is similar to that of after-images. The sensitive coat of the eye has been exhausted, but not to all the constituents of white light, only to the red. The result is that an after-image floats before the eyes, whose colour is that of white light less the red, in other words, the colour which with red goes to make up the sensation of white, the complementary colour of red, namely bluish-green. Similarly if the spot gazed at has been bluish-green, the after-image will be red. If the spot be orange the after-image will be blue, &c. The experiment may also be varied. Thus a large red spot may have a name written across it in another colour, in which case the after-image would show a bluish-green ground and the name would be in a different complementary colour.

HEARING.

The Nature of Sound.

Sound is a form of movement. This may be shown in various ways. We all know that a tightened string may be caused to give out a musical sound by being pulled strongly to one side and then let go. The string makes a rapid to-and-fro motion, which is accompanied by the sound. As the motion becomes less vigorous the sound becomes feebler, and when the movement stops the sound also ceases. The limbs of a tuning-fork are in rapid motion when it is

sounded. In the case of very large heavy forks the to-and-fro movement can be seen; but in the case of small forks, such as those used by musicians, the motion is so fine and rapid that it is not visible. When a bell sounds, after being struck, it can be shown to be in motion; not moving as a whole, but the particles of which its mass consists being in rapid vibration. Now suppose we have a small bell, the hammer of which is worked by clockwork; let us place it on the plate of an air-pump, resting on a thick cushion of felt; and let it be covered with the glass bell-jar of the air-pump. If the clockwork be working we still hear the sound through the glass. Now let the pump be worked so as to remove the air from the chamber, and as soon as a considerable quantity of air has been removed the sound becomes very feeble. When the glass jar has been as completely exhausted of air as possible, the sound is no longer heard, though the hammer may still be seen to strike the bell. The stroke still causes vibrations of the particles forming the substance of the bell, but owing to the absence of air there are no means of communicating the vibrations to the ear of anyone in the neighbourhood. This shows, then, that sound is a movement, that it is only when the movement is conveyed to the ear and affects the nerves of hearing that the sensation of sound is produced, and that it is usually the atmospheric air that acts in conveying the motion to the ears.

The sound movements, or vibrations, as it is better to call them, are conveyed through the air in a wave-like fashion, represented in Fig. 167. The figure shows a tuning-fork, supposed to be sounding. Its limbs are, therefore, in a state of rapid vibration. In the figure what occurs is shown only on one side. The limb a moves to and fro, now in the position a', and now in the position a''. When the limb moves from a to a' the air in contact with it receives a shock, and the particles of the air are crowded together by the blow. When the limb moves from a' to a'' the particles that were crowded together have now more space at their disposal, and are less crowded than before the shock of the limb. But with great speed the limb moves back from a'' to a', and again the particles are crowded, and then it rapidly returns to a'', where the greater space is again created. Thus, while the fork continues to vibrate, the particles of air in its immediate neighbourhood are at one moment crowded together, at another moment the opposite is the case, and this goes on on each side of the fork as long as its movements continue. The crowding together of the particles of air by the shock of the fork is called a *condensation*, and the opposite movement a *rarefaction*. To use these terms, then, the air on each side of the limb of the fork is at one moment in a state of condensation and at another moment in a state of rarefaction, in time with the vibrations of the fork. But this peculiar agitation is not confined to the air that is in immediate contact with the fork. The condensation travels outwards from the fork through the atmosphere, and the rarefaction likewise; and as long as the fork keeps going these two conditions are passed along through the atmosphere from the sounding body, which thus becomes a centre of disturbance, just as a stone thrown into still water imparts a shock to the water, and from the place where it struck waves pass outward on all sides. Fig. 167 represents by the difference in the shading the alternate condensation and rarefaction. Now we all know that a person in a boat on the water will become aware of the agitation of the water, even though at a distance from the centre of disturbance, by the waves rippling up to him. Even so a person becomes conscious of a disturbance in the atmosphere, though he be at a distance from the place where it is produced; because the waves of condensation and rarefaction, spreading outwards on all sides from the vibrating body, at length reach him and beat upon him. They affect his ears, they irritate his nerves of hearing, and so he becomes aware of what he calls sound. If we could see air as we see water, we would perceive the disturbance, caused by a sounding body, passing through it.

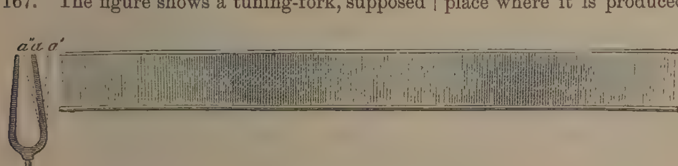


Fig. 167.—Representation of Sound Waves.

It takes a certain time for sound to travel. The rate is about 1090 feet per second when the temperature of the air is 0° Centigrade, and is increased when the temperature is raised. Everyone who has watched the discharge of artillery from a distance knows that the flash and smoke from the gun's mouth are perceived a brief time

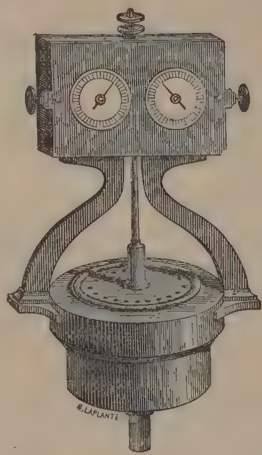
before the report is heard. If the interval between the two be taken, remembering the rate at which sound travels, one may readily make a rough estimate of the distance of the gun—allowance, of course, being made for wind. Now if the atmosphere were visible, with the gun's discharge, a tremendous disturbance would have been seen to take place in the air at the gun's mouth at the moment the flash was seen. This disturbance would be seen spreading outward in all directions and travelling with great rapidity. Suppose the person stood watching the advancing agitation, then, just at the moment when it reached and enveloped him, he would hear the report. So that when a person walks through a crowded and noisy thoroughfare, his ear is being assailed by numberless waves of sound of all kinds and sizes and degrees of rapidity, that surge and swell in the atmosphere around him.

There are various characters of sounds which it is necessary to have some idea of for the proper understanding of the apparatus of hearing. These characters are best exemplified by musical sounds, which are distinguished from ordinary sounds by the regular rhythmical character of their wave movements.

Musical Sounds differ in loudness or intensity, in pitch, and in kind or quality.

The **loudness** of sounds depends on the extent of the vibration or movement—the largeness of the wave, so to speak.

The **pitch** of the sound is determined by the number of vibrations that take place in a second of time. Thus a tuning-fork whose limbs move to and fro 100 times a second will give out a sound of a certain pitch, and a tuning-fork that executes 200 movements in the same time will sound a note of a higher pitch—will, in fact, sound the octave of the former fork. This is shown in a very beautiful way by an instrument devised by a Frenchman, Cagniard de Latour, and called a **siren**. It is shown in Figs. 168, 169. It consists of a metal box, the floor of which is pierced by a tube, placed in connection with a large bellows. In the roof of the box is a small round opening, passing in a sloping direction. Fig. 169 shows a piece cut off the box so as to exhibit this opening. Above the fixed roof of the box, but very close to it, is a round plate, with a number of openings pierced in it, which slope in an opposite direction to that of the roof. This plate turns on a



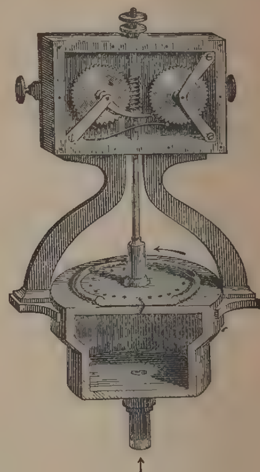


Fig. 168. The Siren. Fig. 169.

fine pivot, so that one hole after another can be brought opposite the opening in the roof. Fig. 169 shows one hole in the plate opposite the opening in the roof of the box, and the different slope of the two openings is seen. Fig. 168 shows the siren complete. Now if air be driven from a bellows into the box, it escapes by the opening in the roof; and as it rushes out it strikes against the edge of the hole in the plate, and the "puff" of the escaping air is heard. The plate, being easily moved, is by this means made to turn, and so the opening in the roof becomes blocked; but when the plate turns a little further a second hole in it comes opposite the opening in the roof, the air again rushes out, produces another "puff," and drives the plate round a little further. Again the opening is blocked, and with the continued turning of the plate it is again speedily opened. If the bellows be worked hard the plate will be driven round fast, and the opening in the roof will be opened and closed very rapidly. Every time it is opened a shock will be given to the atmosphere by the escaping puff of air. Fixed to the apparatus are two dials which mark the number of turns made by the revolving plate. If one knows how often the plate turns in a minute, and the number of holes in the plate, it is easy calculating how many shocks the air will receive in a minute. Now it is found that if the bellows be worked so feebly that the

plate turns so slowly as not to open and close the hole in the roof sixteen times a second, the puffing sound is heard each time the air escapes. But if the hole in the roof of the box is opened and closed sixteen times a second, which would be effected if the plate were turning once a second, and if it were pierced with sixteen holes, then the sixteen puffs are not heard as separate sounds, but are blended together and a low musical sound is heard. If the bellows be worked more and more quickly the plate turns faster and faster, the number of shocks given to the air in a second of time is increased, and the sound is heard to rise in pitch, until with the utmost speed of the plate it becomes a high shrill sound. It is possible, by means of the siren, to discover the number of vibrations made in a second by the limbs of a tuning-fork, sounding a note of a certain pitch. Let the siren be worked till the sound produced is of the same pitch as that of the fork; then by noting the number of times the plate is revolving, as marked on the dials, the calculation may be made. The instrument shows conclusively how pitch of sound depends on the number of vibrations produced by the sounding body in a second of time.

Quality, kind, or **character** of musical sounds depends on something very different from loudness and pitch. We speak of a sound being harsh, or mellow, or rich, &c. We know that a note of the same pitch sounded on a piano, a trumpet, and a violin, differ very markedly in quality, and that a note of the same pitch produced by the human voice differs from them all. Each instrument, that is to say, has a quality of its own. If a tuning-fork of the same pitch be sounded, we are aware of a great difference. The sound might be called thin, or poor, wanting in quality. It is, indeed, so wanting, for a tuning-fork produces what is called a pure sound. But suppose the tuning-fork vibrates 100 times per second, and that we take another vibrating 200 times a second; it will produce a sound the octave of the first. Let us take a third, vibrating 300 times, the octave of the second, a fourth, vibrating 400 times, and so on up to an eighth, vibrating 800 times per second; then we have a set of forks all related to the first, in that they vibrate twice, thrice, four times, &c., as often as the first. If, beginning with the first, they are all sounded one after the other, we perceive the sound of each one immediately after it is produced, but the different sounds immediately begin to blend. When all are sounding we are not aware of eight different sounds, but of one sound of a definite pitch and peculiar quality. The pitch is given by the note of the one with which we began, which is called the **fundamental note,** and the particular quality is due to the blending of the other notes, which are called **overtones** or **harmonics.** The quality may be altered by causing only some of the forks to sound along with the first one; and it is mellow if the forks with fewer vibrations sound, while it is ringing if those with most vibrations are set going. The quality of the sound produced by a violin string is due, therefore, to it vibrating not only to produce the fundamental note to which it is tuned, but also vibrating so as to produce overtones. A piano wire tuned to the same pitch produces a different set of overtones, and thus has a quality of its own, and so with each different musical instrument. In the language of wave movement, the pianoforte wire and the violin string may produce the same *number* of waves in a second of time, but the *form* of the wave is different in each case, and so the quality differs.

These are the chief facts to remember regarding sounds. How the knowledge of them aids in the understanding of the structure of the ear and the perception of sound will be seen immediately.

The Organ of Hearing—the Ear.

The Ear is to be regarded as an apparatus intended to be affected by waves of sound. Connected with it is the nerve of hearing—indeed the ear is to be considered as a peculiar form of nerve ending—so that as soon as the ear is affected by sound the impression is conveyed along the nerve to the brain, and the sensation of sound is produced. Now the nerve of hearing, or auditory nerve, ends in a peculiar structure placed deeply, for protection, in the bones of the head. So deeply is this principal part of the organ of hearing placed that sounds cannot directly affect it. Some arrangement requires to be provided, therefore, for conveying or conducting the sounds inwards towards the nervous structure. The organ of hearing, therefore, consists of two parts:—

1. A part for conveying sound inwards to
2. The nervous portion affected by sound.

The nervous portion is most deeply placed, and is called **the inner ear;** while the sound-conducting portion includes what are called **the outer ear and the middle ear.**

The Outer Ear consists of the appendage,

or **auricle**, at the side of the head, and of a passage that leads inwards from it. The outer appendage is of a peculiar shape, which is not without its uses. For it has been shown that waves of sound falling on the outer ear are, owing to its peculiar curves, directed into the passage. The passage, or **external meatus**, is

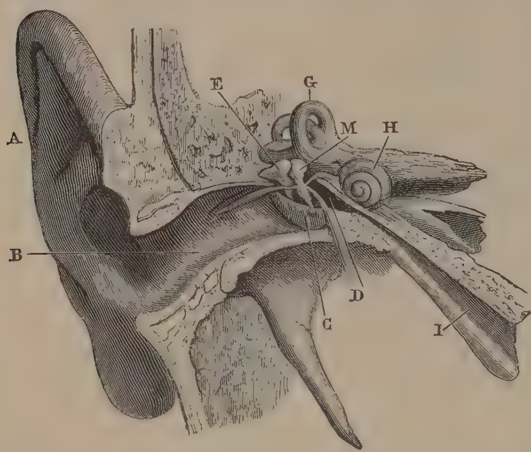


Fig. 170.—The Ear of the Right Side. A, Auricle; B, External canal; C, Drum, partly removed; D, Cavity of middle Ear. E, Anvil, and M, Hammer—small bones of the middle Ear; H, Cochlea, and G, Semi-circular canals of internal Ear. [These latter parts are buried in the temporal bone of the head.] I, Eustachian tube passing from the cavity of the middle ear to the throat.

not straight but curved, and is about an inch and a quarter long. Near its outer portion are a number of fine hairs, which may help to prevent the entrance of insects, &c., while in the deeper parts of the canal, embedded in the walls, are a number of glands, resembling the sweat glands (p. 307) of the skin, which pour out a yellow waxy substance, the **ear-wax** or **cerumen**. This substance keeps the canal moist, and may be produced in excessive quantity—for example, owing to irritated conditions of the walls of the canal, as a result of cold—and the wax may collect in sufficient quantity to block the passage and produce dulness of hearing. It is plain that the business of the outer ear is to collect the waves of sound and conduct them inwards nearer to the inner ear, the true organ of hearing.

The Middle Ear. At the end of the outer ear passage is the **drum of the ear**, or **tympanum**, or **tympanic membrane**. It is stretched quite across the deep end of the passage, which it *completely closes*. It is a thin, unyielding membrane, oval in shape, not flat, but bulging slightly inwards a little below the middle. On the inner side of it is a small cavity, the **cavity of the middle ear**, or cavity of the drum of the ear. This is a small chamber, placed in one of the bones of the head (the petrous portion of the temporal bone, see p. 19), about half an inch in height, and one to two lines in breadth. Its bony walls are lined with mucous membrane—a membrane, that is, similar to that lining the nose, mouth and throat. There are several deficiencies in its walls. In the outer wall an opening in the bone is closed by the drum. The drum, that is to say, is a partition between the passage of the outer ear on one side and the cavity of the middle ear on the inner side. On the inner wall of the chamber are two openings, one round, called the **round window**, or in Latin the **fenestra rotunda**, and another oval, the **oval window, fenestra ovalis**. On one side of the chamber is an opening leading into a tube, about an inch and a half long, the **eustachian tube**, partly made of gristle, and lined with mucous membrane similar to that of the chamber and the throat. This tube passes downwards into the back part of the throat. The tube is usually closed, but it is opened in the act of swallowing. If one firmly closes the nostrils, and performs the act of swallowing, a curious sensation of pressure is felt at the drum of each ear, there is a feeling of great fulness in the ears, and the hearing is not so sharp. If one swallows again, the nostrils being open, the sense of pressure and fulness passes away. The reason is, that by the act of swallowing the pressure of air is increased at the back of the throat, the nostrils being closed, the condensed air cannot escape that way, and rushes up the opened eustachian tubes into the cavities of the middle ear, bulging out the drums and producing the feeling of fulness and pressure. As soon as the act of swallowing is over the tubes close and the air is imprisoned. If swallowing be again performed, the nostrils not being held, the tubes are again opened and the imprisoned air escapes.

It is important to notice that there is, in healthy conditions, no communication whatever between the chamber of the middle ear and the outside except by the eustachian tube. There is no opening between this chamber and the outer passage of the ear in ordinary circumstances, for the drum completely separates the

two. But, as a result of disease or accident, an opening may be made in the drum, or the drum may be destroyed, and then of course the middle ear will communicate with the outside through the passage of the outer ear. Another important practical point is that the membrane that lines the throat is continuous up the eustachian tube with the membrane lining the middle chamber of the ear. Thus redness and swelling of the throat—a cold in the throat (see CATARRH, p. 154)—is usually accompanied by some degree of deafness, because the swelling passes up to the middle ear, and blocks the chamber.

A chain of small bones—the **auditory ossicles**—extends across the cavity of the middle ear, reaching from the drum in the outer wall to the oval window in the inner wall. These bones are three in number, and from their appearance were called **malleus** or hammer, **incus** or anvil, and **stapes** or stirrup. They are shown in Fig. 171, the upper part showing the stirrup bone, and the lower the bones connected. The resemblance of the third bone to a stirrup is striking. By the long downward projection (2) the hammer-bone (1, 2) is fixed to the inner surface of the drum of the ear, the projection at the side attaching it to the bony wall of the chamber in which it is lodged. The round head (1) of the hammer (3, 4) is connected with the anvil (3) by a movable joint, while the long projection of the anvil (4) is similarly connected with the stirrup-bone (5). The plate of the stirrup is fixed by membrane into the oval window of the inner wall of the chamber of the middle ear. Thus across this chamber this chain of three bones is stretched, placing the two walls of the cavity in communication. Moreover, on the inner side of the oval window is a cavity, part of the internal ear, where is lodged the essential portion of the organ of hearing. The membrane which closes the oval window, therefore, and to which is fixed the plate of the stirrup, separates the cavity of the middle ear from the internal ear.

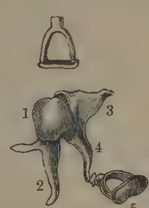


Fig. 171.—Ear-bones.

The purpose of the external and middle portions of the ear now becomes evident. Waves of sound are produced in the atmosphere about us. These waves reach us, and are directed by the appendage of the ear up the external passage, at the end of which they meet the drum. The drum is a thin membrane, and, when waves of sound beat upon it, it is thrown into vibration, reproducing, it is to be remarked, in its movements the characters of the sound-waves that have fallen upon it. But to the inner surface of the drum is attached one end of the chain of bones, and since that chain is movable, the vibrations of the drum will be passed along the chain and reach the stirrup. The stirrup fits into the oval window by means of a membrane, and the stirrup and membrane will consequently be caused to perform to-and-fro movements at the oval window, passing the movement inwards to the structures of the internal ear beyond. Thus by means of the external appendage, the external canal, the drum, and the chain of bones, the movements in the air caused by a sounding body are communicated to the internal ear.

It may be added that three small muscles are connected with the chain of bones. Two are connected with the hammer, one (the **tensor tympani**) so pulls on it as to tighten the drum to which it is attached, the other pulls in the opposite direction and relaxes the drum (the **laxator tympani**). One small muscle is attached to the stirrup (the **stapedius**) whose contraction prevents the stirrup being pushed too deeply into the oval window. The external and middle parts of the ear evidently form a *sound-conducting apparatus*. If the external passage be blocked by wax or other substances, if the drum be thickened by disease, injured or destroyed, or if the chain of bones loses its power of movement as the result of inflammation of the middle ear, partial or complete deafness of that ear is to be expected.

Having seen how sound is conducted to the internal ear, we must now see what arrangements exist in that part for receiving the sounds led to it.

The Internal Ear consists of a curiously shaped structure buried in the temporal bone (p. 19). It is represented in Fig. 172. The opening, marked 2, is that of the oval window, on the inner wall, as we have seen, of the cavity of the middle ear, and closed by the stirrup-bone and its membrane. This opening leads into a small chamber, about $\frac{1}{5}$th of an inch in diameter, called the **vestibule**. From the back part of the vestibule there open three tubes, the **semicircular canals**, so called because of their shape, which are $\frac{1}{20}$th of an inch in width and make a curve of about $\frac{1}{4}$th of an inch in diameter. One is directed horizontally (4), another upwards (3), and the third backwards (5). Opening from the vestibule by these separate open-

ings, they also join it again. The upper and back one are united at the other end and rejoin the vestibule by a common opening. Thus there are

Fig. 172—Bony Internal Ear of the right side; the upper figure magnified, the lower of the natural size.

five openings connected with the canals. Each canal has a bulging part at one end called an **ampulla**, marked thus * in the figure. From the fore part of the vestibule there passes a tube, which makes two and a half turns, coiling like a snail's shell. It is termed the **cochlea** (6, 7, 8, Fig. 172). At the base of the cochlea is the opening of the **round window** (9, Fig. 172) which communicates with the cavity of the middle ear (p. 356), but in the recent state is closed by a membrane. Besides the openings already mentioned the vestibule has several small apertures in its inner wall, by means of which there enter branches of the nerve of hearing—auditory nerve (p. 96). All these parts, vestibule, semicircular canals, and cochlea, are formed of bones, and to the whole structure the term **bony** or **osseus labyrinth** is applied. The inner surface is lined by membrane, and the labyrinth contains a fluid, the **perilymph.**

But this bony labyrinth forms only an outer casing for a membranous labyrinth. Fig. 173

Fig. 173.—The Membranous Labyrinth.

represents the complete membranous labyrinth. It is formed of two sacs which are lodged in the bony vestibule. The larger of these sacs (*d*) is called the **utricle**, the smaller the **saccule** (*e*). These, it is to be remembered, are lodged in the bony parts described, and separated from the bony walls by the fluid—perilymph—contained in the bony labyrinth. Passing off from the utricle (*d*) are membranous semicircular canals (*a*, *b*, *c*), lying in the bony canals of the same name, surrounded by the perilymph. The inner surface of the utricle and membranous canals is lined by epithelial cells (p. 16), and from the surface fine hairs project into the interior, which contains a fluid—the **endolymph.** Branches of the nerve of hearing pass to the sac and canals, and are supposed to be in connection with the hair-like processes. The nerves are specially distributed to the sac and the bulgings of the membranous tubes. Now if these hair-like processes are connected with nerve-fibres, the slightest agitation of the fluid in the membranous canals will disturb the hairs and consequently affect the fibres of the nerve of hearing. Within the sac of the utricle are found minute crystals of carbonate of lime—**otoliths**—which may be supposed, on disturbance of the fluid, to affect more strongly the hair-like projections from the walls.

The smaller sac, the saccule (*e*), lodged also in the bony vestibule, communicates by a fine canal (*f*) with the membranous canal (*g*) contained in the shell-like cochlea, and called the **canal of the cochlea.** Further, it is found that the two sacs communicate with one another by a very fine tube, so that the whole membranous labyrinth is connected together.

The **membranous canal of the cochlea** (*g*) is the most important part of the internal ear, since in it is lodged the apparatus that is believed to be the chief agent in the perception of sound. It has already been mentioned that the cochlea possesses an outer bony case, resembling in appearance the shell of a snail (6, 7, 8 of Fig. 172). But we must now describe this bony part rather more particularly. If the cochlea be opened into, there is seen to be a central bony pillar, round which the bony tube is wound two and a half times. The central bony pillar is called the **modiolus.** The bony tube is not regular inside. From that part of it which lies against the central column, as it winds round, there projects inwards a bony ridge — the **lamina spiralis.** At the base of the bony cochlea, just where it begins to wind round the modiolus, this ridge projects well into the space of the bony canal, dividing it almost into two compartments; but as the bony canal winds round the column, the lamina spiralis, which, of course, follows the turnings, becomes less and less projecting, till at the blind end of the bony

cochlea it is not nearly so prominent. Fig. 174 shows the cochlea with part of the wall removed to show the interior. From E straight

Fig. 174.—The Cochlea opened up (magnified).

downwards is the direction of the central column—modiolus—to which D points: B B point to the projecting ridge—lamina spiralis—almost dividing the canal of the tube into an upper compartment C and a lower A. (Refer also to Fig. 175.) Now in the recent state this partial division of the tube is completed by membranes, so arranged as to form a membranous canal within the bony one—the **membranous canal of the cochlea.** This will be understood from Fig. 175. This represents the cochlea cut straight down from top to bottom. M is the central column: A, B, C, and D are complete sections of the bony cochlea, in different parts of its winding, cut across. In each

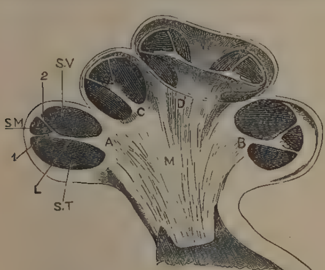


Fig. 175.—Vertical Section of the Cochlea of a Fœtal Calf.

cross section L points to the lamina spiralis, projecting inwards from the central column. From the edge of this ridge two lines (1 and 2) are seen passing outwards, and diverging as they pass, to the outer wall of the bony canal. These are membranes; the lower (1) is called the **basilar membrane,** the upper (2) is the **membrane of Reissner.** These two membranes thus complete the division between the upper and lower part of the bony tube. The upper division (S.V.) is termed the **scala vestibuli** (the staircase of the vestibule), the lower (S.T.) is the **scala tympani** (the staircase of the tympanum). Inasmuch, however, as the two membranes separate from one another as they pass across, they inclose between them a triangular space. It is this space (S.M.), formed by the basilar and Reissner's membranes and the part of the bony wall between them, that constitutes the membranous canal of the cochlea, or the **scala media** (middle staircase) of the cochlea. This part of the bony wall is, like the rest of it, lined by a membrane. Thus we have the bony cochlea throughout its two and a half turns divided into three compartments; and within the bony canal of the cochlea we have a membranous canal, occupying only a small part of the space. Now at the base of the cochlea, that is, at the beginning of the first turn, the scala of the vestibule opens into the bony vestibule already described, while at the foot of the scala of the tympanum is the round window, closed and separated from the cavity of the middle ear by a membrane. As we have seen, the vestibule has an opening in its wall—the oval window—on the outer side of which is the cavity of the middle ear, but which is closed in the bony state by the stirrup-bone and its membrane. At the top of the cochlea the scala vestibuli and the scala tympani communicate with one another by a small opening called the **helicotrema.**

Suppose, then, we begin with the external canal of the ear. Passing up it for an inch and a quarter we reach the drum. On the inner side of the drum is the cavity of the middle ear, across which stretches the chain of small bones, one end of which is attached to the inner surface of the drum, and the other end of which—the stirrup—is inserted into the oval window. On the inner side of the oval window is the bony chamber of the vestibule, opening from which is the scala vestibuli. Entering this staircase we pass round two turns and a half to the top of the cochlea. Part of the floor of this scala is the membrane of Reissner, which is also the roof of the scala media. Reaching the top we pass through the small opening of the helicotrema, and enter the scala tympani, down which we pass two turns and a half. Part of the roof of this staircase is the basilar membrane or floor of the scala media, which is thus inclosed between the two staircases. Arrived at the foot of the scala tympani we reach the round window, closed by a membrane, on the outer side of which is the cavity of the middle ear.

Next it is to be observed that the scala vestibuli and scala tympani are both filled with a fluid—perilymph. Consequently waves of sound in the atmosphere pass up the external passage and throw the drum of the ear into vibration.

These movements are conducted across the chain of bones to the oval window, and cause the stirrup-bone to make to-and-fro movements at the window. These throw the fluid in the vestibule into vibrations, which pass up the one staircase and down the other and are spent at the round window. As these waves pass along the fluid they communicate movement to the membrane of Reissner, the floor of the vestibule staircase, and to the basilar membrane, the roof of the tympanic staircase. These membranes are respectively the roof and floor of the middle scala or membranous canal, and this canal also is filled with fluid—endolymph—which is consequently agitated. Consequently the vibrations of a sounding body ultimately communicate movement to the fluid contained in the membranous canal or middle staircase.

The membranous canal of the cochlea then lies in the bony cochlea, inclosed between the two staircases, but it does not open into either. At the top of the cochlea it ends blindly. Its base lies in the bony vestibule, but does not open into it. By a small canal (*f*, Fig. 173), however, it has connection with the saccule.

Within this membranous canal and resting on the basilar membrane is a remarkable structure, first described by the Marquis Corti, and hence called **Corti's organ.** It is a very complicated structure, which it is needless to try to describe here. It consists mainly of a series of fibres—**fibres of Corti**—each made of two parts resting against one another so as to form an arch. These arches are placed, side by side, in a continuous series along the whole length of the basilar membrane. In the human ear it has been estimated that there are no less than 3000 of such arches. When viewed from above downwards by a microscope, they present the appearance of the key-board of a piano. Fig. 176 A

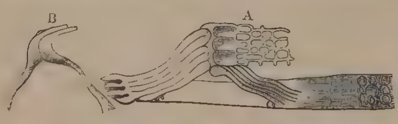


Fig. 176.—Arches of Corti's Organ (very highly magnified).

shows a few of the arches side by side, B of the figure exhibiting two fibres forming an arch. It would appear that the arches are supporting structures. For, resting on them, are numbers of conical epithelial cells (p. 16), from the free surface of which bundles of stiff hairs project. It is believed that these hair cells are the true sound-perceiving structures.

We have seen how vibrations of a sounding body reach, in the end, the membranous canal of the cochlea, containing Corti's organ. The fluid contained in this canal will be thrown into vibrations, and these in turn will affect the hairs of the cells supported on Corti's rods. These hair cells are in communication with nerve-fibres, which pass into Corti's organ through channels in the modiolus, or bony pillar round which the cochlea is wound. Thus the vibrations communicated to the hairs will affect the nerve-fibres, and cause messages to be sent along the nerves to the brain, resulting in sensations of sound.

The Sense of Hearing.

The Perception of Sound. The description that has been given of the very complicated structure of the ear will enable one to perceive how sounds are conveyed into the depths of the ear, but it is extremely difficult to understand how that apparatus enables us to have knowledge of all the multitude of various sounds of which we are daily conscious.

We must go back again to the physical world to get light on the difficulty. It is a well-known fact that if one takes two tuning-forks, such as are used for experiment in a natural philosophy laboratory, both tuned to sound exactly the same note, and if the forks are placed at some distance from one another, and one of them is made to sound, the other not being touched, in an instant both will be heard sounding. The sound of the one fork has set the other agoing. This, it must be noticed, happens only if both utter a note of the same pitch. If the two forks sound different notes, the one may be set humming loudly and long, the other remains dumb. But if the two are tuned to the same note the one is no sooner set sounding than the other is heard humming also. This is called **sympathetic vibration,** but there is no mystery about the occurrence. The one fork produces waves exactly similar to those the other would produce. When, therefore, one is sounded, the waves pass out and reach the other fork, against which they strike. Wave after wave hitting on the fork, each wave exactly suiting the swing the fork makes when in motion, gradually sets it into vibration. It is just like a small boy setting in motion a swing on which a heavy boy is sitting. If he tried to make it give a big swing with one push, he might push with all his might and accomplish nothing. If he be a wise small boy, however, he does not attempt this. He gives the swing an ordinary push, and it swings

slightly. He waits till it has moved forward, then backwards, and just as it is about to sway forwards again, he gives it another push, which, added to its own impulse, increases its movement. So he goes on till, in a short time, he has it in full swing. But if he does not time his pushes properly he will speedily stop the swing. It is the same with the tuning-fork. Each wave from its neighbour reaches it at the proper time and speedily sets it in full vibration. If now the second fork have one limb loaded, say with a piece of wax, the note of the fork is flattened. It is no longer in tune with the first one, and can no longer be set in sympathetic vibration with it, because its swing is no longer in time with the waves of its neighbour. One fork, therefore, can be set in vibration only by another sounding exactly the same note; and the fork will recognize its own note and hum in harmony with it, though the sound reach it from a considerable distance.

Suppose, then, that, on a table at one end of a room, one had a set of tuning-forks, each tuned to a particular note. Let a number of musicians proceed to play on their instruments at the other end of the room. No matter how complex the body of sound they produce, each tuning-fork will pick out infallibly its own note from the mass of sound, if its own note happens to have been produced; and if the players suddenly cease the tuning-forks will be heard sounding. By finding which of them are vibrating, one can tell what notes were produced by the players. Suppose one could have a set of tuning-forks, so numerous that there was one for every note that could be sounded, it is evident one would have here an apparatus for analysing the complex sound, that is, splitting it up into its elements. One may try a simple experiment of this kind with a piano. Let the damping pedal be lifted from the wires, and let someone sing loudly in the room, and then suddenly stop. Some of the pianoforte wires will be heard sounding. They have picked out of the song their own notes, and have been set in sympathetic vibration by them.

Now it is believed that it is somewhat after this fashion that the internal ear perceives sound. It has been noted (p. 360) that, in the internal ear, the organ of Corti contains a large number of cells with hairs projecting from them. It is supposed that each hair is sensitive to a particular vibration. The vibrations of a sounding body are conducted to the internal ear in the manner already described, and agitate the fluid in the membranous canal of the cochlea. The waves produced will be complex waves, compounded that is of simple waves of different lengths, &c. Each hair, however, will vibrate in harmony with one particular simple wave, and if that one be contained in the complex one, it will pick it out and vibrate to it. Thus the complex wave of sound will be split up into simpler forms, each hair selecting and vibrating to its own, and a multitude of hairs will be set simultaneously vibrating by the mass of sound. The ear is thus an organ that analyses (splits up) sounds into their elements.

In support of this view it may be mentioned that hairs on the feelers of the Mysis, an animal belonging to the same general class as crabs and lobsters, have been seen to vibrate in harmony with particular notes and with these notes only.

Each hair cell is in communication with a nerve-fibre, and the vibration of each hair will thus cause an impression to be passed along a nerve. The various impressions will be passed along to the hearing centre in the brain, where they become fused, and the person is conscious of a sound of a particular kind. While the ear splits up complex sounds, and communicates to the brain the elements of which they consist, the brain reunites them. We are not conscious of the splitting up process but only of the union.

The Range of the Ear for musical sounds has been determined to be from 32 to about 30,000 vibrations per second. That is to say, 32 vibrations per second produce the sensation of a low musical note, the lowest the human ear can appreciate, while vibrations occurring at the rate of about 30,000 per second produce the sensation of a very high pitch, the highest the human ear can appreciate. Vibrations more rapid cannot be taken knowledge of by the ear.

The Sensation of Discord in music is due to the interference of two sounds which are nearly of the same pitch. As two waves in water may abolish one another if the crest of one meets the hollow of another, and may again add to one another's size by the two crests meeting, so two waves of sound differing slightly from one another may at one moment almost extinguish the sound by interference and at the next produce increased loudness of the sound by being added to one another. The result is the production of what in music is called **beats**, characterized by a rising and falling of the sound. The effect on the ear is similar to the effect of a flickering light on the eye. When

the beats occur with sufficient rapidity they give a sensation of roughness to the sound, greatest when they number 33 in a second. When they reach the number of 132 in a second they are no longer perceived. Two notes that when sounded together produce beats are recognized as discordant notes.

Judgments of the direction of sound are not actually performed by the ear; they are the result of various other circumstances. Anyone can prove this by shutting the eyes and trying to decide the direction from which a sound is coming. The distance from which a sound proceeds we judge of by its loudness or faintness. It is such facts as these that the ventriloquist takes advantage of to deceive people. He imitates the character of sound from a distance, or from some particular place, by giving it the required degree of loudness, and by directing the attention of the person to that quarter, &c., his own face at the same time giving no sign of movement.

"Educating the ear" is a phrase which derives force by all that is known about the mode of action of the organ of hearing. We have seen that the ear actually analyses or splits up sounds into their simple elements, and that the brain fuses the elements together again. The habit is to pay attention only to the fused sensation. But we all know that the trained musician detects the elements of a complex sound, while the person who has given no attention to his sensations knows only, perhaps, that the sound is pleasant or the reverse. Just as surely as every ear performs the same process of analysis, so may every person, by careful training, become able to perceive something of the analysis, and to detect some of the varied elements of musical sounds that he listens to. The difference, indeed, between a "good ear" and a "bad ear" is to a large extent the difference between careful training and bad training, or no training at all. Something, of course, must be admitted to natural aptitude; but the excuse many people offer for their ignorance of music, that they have "no ear," is no excuse at all, in view of the facts that have been stated—is, indeed, but another way of implying carelessness and neglect. Just as the man, who is not blind, would be laughed at if he offered, as an excuse for being unable to read, that he had no eye, so ought a person, who is not deaf, to be laughed at if he offers, as an excuse for being unable to distinguish one note from another, or different notes in a chord, that he has no ear.

SECTION XII.—THE SENSES AND SENSE-ORGANS.

B.—THEIR DISEASES AND INJURIES.

Affections of the Sense of Touch.

Loss of Sensibility of the Skin (*Anæsthesia*);
Increased Sensibility (*Hyperæsthesia*);
Perverted Sensibility.

Affections of the Sense of Taste.

Excessive or Perverted Sensitiveness of Taste;
Loss of Taste.

Diseases and Injuries of the Nose and Affections of the Sense of Smell.

Diseases of the Nose:
- *Cold in the Head;*
- *Chronic Discharge from the Nostrils;*
- *Stink-Nose* (*Ozaena*);
- *Ulceration in the Cavity of the Nostrils;*
- *Tumours of the Nose;*
- *Foreign Bodies in the Nostrils;*
- *Bleeding from the Nostrils* (*Epistaxis*);
- *Injury to the Nose;*
- *Sneezing.*

Affections of the Sense of Smell.
- *Loss of the Sense of Smell* (*Anosmia*);
- *Over-acuteness of the Sense of Smell.*

Diseases and Injuries of the Eye and Affections of the Sense of Sight.

Diseases of the Eyelids:

Skin Affections of the Eyelids;
Inflammation round the Eyelashes (Blepharitis);
Turning outwards or inwards of the Eyelids (Ectropion and Entropion);
Stye (Hordeolum);
Tumour of the Eyelid (Chalazion);
Inflammation of the Inner Surface of the Eyelids (Cold-in-the-Eye—Conjunctivitis);
Pustules (Phlyctenæ);
Thickening of the Lining of the Lids (Granular Lids—Egyptian Ophthalmia—Trachoma);
Burns—Symblepharon and *Anchyloblepharon,* or unnatural union of the lids to the eyeball and to one another;
Foreign Bodies within the Eyelids;
Drooping of the Eyelids (Ptosis);
Inability to shut the Eyelids;
Twitching of the Eyelids;
Bruises and Wounds of the Eyelids.

Diseases of the Tear Apparatus:

Obstruction of the Tear Passage.

Diseases of the Eyeball:

Inflammation of the Cornea (Keratitis);
Abscess and Ulcer of the Cornea;
White Spots on the Cornea (Opacities)—The operation for artificial pupil (*iridectomy*);
Staphyloma;
Foreign Bodies in the Cornea;
Wounds of the Cornea;
Inflammation of the White (Sclerotic) of the Eye;
Inflammation of the Iris (Iritis);
Cataract—The operation for its cure;
Diseases of the Retina, Choroid Coat, and Optic Nerve (Retinitis—Choroiditis—Optic Neuritis);
Separation of the Retina (Dropsy of the Retina);
Glaucoma;
Examination of the Eye by the Ophthalmoscope;
Foreign Bodies within the Eyeball—Sympathetic Inflammation;
Rolling Eyeballs (Nystagmus);
Squint (Cross-eyes—Strabismus).

Affections of the Sense of Sight:

Short-sight (Myopia) and Long-sight (Hypermetropia)—Treatment by Spectacles;
Weak-sight (Asthenopia); *Defective Sight from Age (Presbyopia)*;
Astigmatism;
Blindness (Amaurosis and Amblyopia); *Partial Blindness of One Eye (Hemiopia)*;
Night-blindness (Hemeralopia)—Snow-blindness and Moon-blindness;
Colour-blindness (Daltonism);
Double Vision.

The Care of the Eyes.

Diseases and Injuries of the Ear and Affections of the Sense of Hearing.

Diseases and Injuries of the Ear:

Diseases of the Auricle;
Inflammation of the Canal of the Ear—Boils in the Canal;
Wax in the Ear to Excess—Syringing the ears;
Growth in the Canal of the Ear (Polypus); *Foreign Bodies in the Ear;*
Inflammation of the Drum;
Injury to the Drum—Bursting of the drum by blows, diving, &c.;
Inflammation of the Middle Ear;
Earache;
Discharge from the Ears (Running Ears).

Affections of the Sense of Hearing:

Deafness;
Noises in the Ears.

Deaf-Mutism.

Care of the Ears.

AFFECTIONS OF THE SENSE OF TOUCH.

There are two main diseased conditions of the sense of touch, one in which the sense is abolished, which is called **anæsthesia** (Greek *a* not, *aisthanomai*, to feel), and the second in which the sense is unnaturally acute, called **hyperæsthesia** (Greek *huper*, in excess). The sense may also be perverted.

Loss of Sensibility of the Skin (*Anæsthesia*) may be due to disease of the nerves of sensation supplying the skin, or to disease of the nerve-centres, namely, the brain or spinal cord. Thus pressure of a tumour on a nerve, injury to a nerve, may produce it, while it is often produced in apoplexy and other brain diseases.

Sometimes the action of irritating substances on the skin will produce a numbness, though not exactly a total loss of sensation.

One remarkable form of loss of sensibility occurs in hysteria. In it the sense of touch, including sensations of contact, of heat and cold, and of pain, is lost on the whole of one side of the body, so that pins may be thrust into the body on one side without producing any evidence of feeling on the part of the patient. As soon as the middle line of the body is crossed, however, the sensibility is found perfect. Indeed the dividing line between the sensitive and not sensitive portions of the body is remarkably sharp. This affection is called **hemianæsthesia**, from its being limited to one half of the body.

The recognition of the cause of this disease and its appropriate treatment are subjects of considerable difficulty. The disease is essentially a nervous one.

Increased Sensibility (*Hyperæsthesia*) may be to touch proper or to pain. In some cases it is so marked that the slightest touch produces a feeling of intense pain. It occurs in connection with neuralgia, hysteria, and gunshot injuries of nerves. The increased sensitiveness may be to heat or cold.

Perverted Sensibility may be shown by contact with hot or cold objects being felt not as sensations of heat or cold but of pain. There may be feelings of burning or tingling in the skin, feelings as of the creeping of insects over the body, &c. This also is a nervous disorder. It is called **paræsthesia**.

AFFECTIONS OF THE SENSE OF TASTE.

Excessive or Perverted Sensitiveness of taste may occur. An extremely small quantity of some substance may give rise to an intense impression on the taste sense, or a very prolonged impression, or quite a different impression may be made from what is natural. Such cases are met with in the hysterical and insane. Further, tastes may be felt quite apart from any substance taken into the mouth, as a result of irritation of the nerves of taste, by disease for example. Certain substances present in the blood will cause a taste to be felt. The taste of some substances may be felt when they have been injected under the skin and not taken into the mouth at all. Everyone also knows how disordered conditions of stomach and bowels give rise to bad tastes in the mouth.

Loss of Taste occurs in hysteria and nerve affections. Thus it may result from rheumatic inflammation of certain nerves that supply the mouth and face. It may be associated with paralysis of the face, and may be lost only on one side of the tongue. Since the tongue is supplied by two nerves, so far as taste is concerned, one supplying the front part and another the back part (see p. 337), the sensibility of one part may be lost and that of the other retained. Loss of taste may also arise from no affection of nerves, but from thickening of the surface of the tongue or mouth rendering the ends of the nerve-fibres less easily affected by the tasty substance.

Affections of the tongue have been considered on p. 150.

DISEASES AND INJURIES OF THE NOSE AND AFFECTIONS OF THE SENSE OF SMELL.

Diseases and Injuries of the Nose.

Cold in the Head or nasal catarrh, which usually begins by attacks of sneezing and then goes on to a free discharge from the nostrils, has been sufficiently described under CATARRH (p. 154).

Chronic discharge from the nostrils is frequently the result of chronic catarrh, that is, of repeated attacks of cold in the head. As a result the person is annoyed by a thick discharge or by swelling of the lining membrane, causing "stopped nose," thickness of speech,

defective smell, &c. A chronic discharge from the nostrils is a feature of glanders, a disease of the horse communicable to man. It is mentioned under FEVERS.

Treatment consists in using as a snuff a powder of bismuth and alum or chlorate of potash, diluted with five or six parts of powdered starch or gum-arabic. A lotion may be used made of borax, alum, and tannin, or chlorate of potash, in the strength of 10 grains to half an ounce of water and half an ounce of glycerine. Some of this should be thrown into the nostrils by means of a syringe, consisting of a small elastic ball with a short glass nose-piece.

Stink-Nose (*Ozœna*) is the term applied to the condition in which the discharge from the nostrils is very offensive. It often depends on ulceration of the nostrils high up, and may be attended by a sense of weight or fulness high up. It may begin with some foreign body which has passed up the nostrils and lodged, setting up inflammation and ulceration by its continued presence, and ultimately leading to disease of bone. Every case of stink-nose in children should be carefully examined for some foreign body, which the child may have pushed up the nostrils. After bleeding of the nose a large clot of blood may be retained and cause, in time, an offensive discharge. Various diseases may also be the cause of ozæna—syphilis, for instance.

Treatment. — First of all care should be taken that the cause of the mischief is not a foreign body. This is necessary specially in the case of children. The nostrils should be regularly cleansed by syringing. One very efficient method may be described, which only needs a little practice. A vessel is got capable of acting as a cistern, a tin can fitted near the bottom with a stop-cock would do admirably. It is filled with water and fixed on a shelf a little above the person's head. An india-rubber tube fits on to the stop-cock and passes downwards, ending in a nozzle, capable of filling the nostril. The person stands with his head slightly bent over a basin. The nozzle is inserted into one nostril (*the healthy one*), the other being left free. The patient keeps his mouth open, breathing through it, and not permitting himself to perform the act of swallowing. If now the water be turned on it passes through one nostril to the back of the throat, passes out by the opening at the back (see p. 338), does not go down into the throat but enters the back opening of the other nostril and washes through it coming out at the front, where it is caught by the basin. By this method, *provided the patient breathes through his open mouth and does not swallow*, both nostrils can be washed thoroughly. If the person cannot get used to this method he may employ any small syringe.

Along with the washing out, by whatever method accomplished, lotions of various kinds may be used. One or two teaspoonfuls of solution of chlorinated soda to a pint of water is useful in very offensive cases, or a weak solution of Condy's fluid, water made just pink with it, or solution of carbolic acid one ounce to 60 or 80 of water—3 or 4 pints. A useful paint for injecting by a syringe, is glycerine with iodine, one grain of iodine dissolved in one ounce of glycerine.

Besides such local treatment the patient will often be benefited by taking cod-liver oil, quinine wine, tonics, &c.

Ulceration in the cavity of the nostrils will be attended by offensive discharge and is to be treated as "Stink-Nose." If the ulcer can be reached by the finger an ointment of one part of iodoform and four of vaseline should be applied. Long-continued ulceration sometimes eats through the division between the nostrils, destroying bone and gristle. This is usually the result of syphilis.

Tumours of the nose. The commonest tumour in the nostrils is what is termed **polypus**, a growth from the lining membrane, of varying size, hanging as it were from a stalk.

Symptoms. A polypus usually blocks the nostrils, so that the person has to breathe through the mouth, which is constantly kept open. The voice is generally altered and acquires a nasal twang. The finger may detect the growths, which feel like a bunch of earth-worms.

Treatment.—The best treatment is removal by a surgeon if the swelling can be reached. Washing the nostrils by means of a syringe with water containing a small quantity of salt or bicarbonate of soda (30 grains to the pint) relieves.

Warts may occur in the nose, they usually occur just within the nostril. They should be touched with glacial acetic acid, as advised for warts on p. 322. **Cancerous** and other tumours may also be present in the nostrils.

Foreign bodies in the nostrils are not uncommon in children. Cherry-stones, peas, and

even nails are often pushed into the nostrils by them. Sometimes the child says nothing about it, till after a longer or shorter time the presence of the foreign body has set up irritation, and produced discharge, which is usually offensive. Delay always renders the removal more difficult, since the substance becomes surrounded by secretion and is firmly lodged. Persistent discharge should always lead to an examination for a foreign body.

Treatment.—Let the free nostril be closed and cause the person to blow through the blocked nostril as strongly as possible. If this fails, as it often will, if the substance has been in the nostril some time, a stream of water may be employed. The nostril may be syringed from the front. If the person is old enough the method of washing out the nostrils described on p. 365 may be used, the tube being inserted into the *sound* nostril, so that the water flows on the blocked side from behind forwards. Instruments should not be used except by a surgeon. If the aid of a hairpin is likely to extract the foreign body, it may be used, *but always the looped end;* the sharp point should always be avoided.

Bleeding from the nostrils (*Epistaxis*), occurring without any apparent cause, is rather common among young people. In girls it may be a source of relief at the monthly periods. Besides such cases it may attend the onset of typhoid fever, typhus, remittent, and scarlet fever; and it is a prominent feature in scurvy, purpura hæmorrhagica (p. 237), and other diseases. It may be due to diminished atmospheric pressure, and from this cause occurs to persons in ascending high mountains. The flow comes from one nostril as a rule, and rarely from both at once. It may, as everyone knows, be due to injury.

In severe cases much loss of blood may take place and fainting result, while frequent attacks may rapidly reduce a person's strength.

Treatment.—Let the nostril be firmly closed by pressure with the hand for several minutes, the head being held high. Cold, in the form of cold-water cloths, applied to the nose, neck, and forehead, are very useful, iced-cloths being still more effective. If measures like these are useless, plugging the nostril must be resorted to. This is done with pieces of lint rolled into the form of a cone and pressed in from the front. Sometimes it is necessary to plug from behind, but only a surgeon can do this.

Should attacks be common the patient ought to have tincture of steel and quinine administered for some time.

Injury to the nose. Fracture of the bridge of the nose as the result of a blow may be recognized by the alteration of shape, and by the grating feeling if a finger be gently pressed on each side of the bridge. The broken nose may often be restored to its proper position by gently moulding with the fingers. If the bones are pressed down, they may be lifted by carefully passing up the nostril something like the bone or ivory handle of a pen or pencil-holder. If necessary, some cotton-wool may then be passed up to keep the bones from falling in again. On the outside the application of strips of sticking-plaster may help to keep the parts in place. *Immediately* after the blow cold cloths are useful in keeping down bleeding and swelling; but *some time* after hot cloths freely applied reduce swelling and pain rapidly.

A **bruise** on the bridge of the nose without injury of bone is best treated by hot cloths. When swelling has disappeared the soft parts may be adjusted as well as possible by narrow strips of skin-plaster.

Sneezing may become uncontrollable so as to be actually a disease. The ordinary explanation of sneezing is that something irritates the lining membrane of the nostril, and the sneeze is designed to expel the cause of the irritation (see p. 261). Excessive sneezing occurs in hay-fever (p. 274), due, it is supposed, to the irritation set up by the pollen of certain plants. It is a common sign of the onset of cold-in-the-head. It is, however, sometimes associated with whooping-cough and asthma, gout, and hysteria. It sometimes occurs connected with disturbance of sexual functions in women and connected with pregnancy.

Treatment.—The effect of strong smelling-salts may be tried. If so severe a measure is necessary, a mustard blister to the nape of the neck is useful. Where they seem to be indicated, quinine and iron tonics should be administered.

Affections of the Sense of Smell.

Loss of the Sense of Smell (*Anosmia*) may be due to unusual conditions of the lining membrane of the nostrils, such as swelling, thickening, &c., resulting from chronic catarrh (p. 154), or the presence of growths preventing the proper entrance of air, or to altered conditions such as may be induced by constant snuff-taking. A

second class of causes includes such as affect the nerve of smell—the olfactory nerve (p. 95). A blow on the head may abolish the sense of smell by injury to the nerve. Abscesses, disease of bone, may act in the same way. While, in a third class of cases, loss of smell is caused by disease in the brain affecting the nerve-centres for smell.

The loss may be on one side only. Loss of smell will also be accompanied by loss of flavour, since flavour includes smell as well as taste (p. 337).

Treatment is directed to the cause. Cases of chronic catarrh should be treated as advised on page 364 for chronic discharge.

Over-acuteness of the sense of smell occurs in hysteria, and as a result of weakness from chronic disease. Further, sensations of smell may be experienced without any external cause. One might call them delusions of smell. Thus a constant sense of a bad odour has attended disease of the brain and other diseases also.

DISEASES AND INJURIES OF THE EYE AND AFFECTIONS OF THE SENSE OF SIGHT.

Diseases of the Eyelids.

Skin Affections of the Eyelids. Like the rest of the covering of the body the eyelids are liable to various skin affections. These are sufficiently discussed in Section XI. B. One only need be mentioned here. It consists of an eruption of blebs, filled with clear fluid at first, but later with yellow matter. They spread from the inner part of the eyebrow over the forehead and up among the hair, and also downwards over the eyelids and the side of the nose. They are accompanied by severe pain and swelling and inflammation of the eye. The lids are so swollen that the eye is closed. This is an eruption quite similar to shingles, and properly called by the same name—**herpes**. It is treated in a similar manner (p. 317).

Inflammation round the Eyelashes (*Blepharitis*). This is really an inflammation of the hair-sac from which an eyelash springs. It begins in little swellings on the edge of the lid round a hair, and rapidly spreads along the edge. Crusts form which stick to the lid, mat the hairs together, and produce a very unsightly appearance. The lids become thickened and red. Little points of matter often form. If the disease lasts long, the lashes fall out, so that the lids may be entirely deprived of lashes. Owing to the thickening the lids are turned outwards; the tears no longer readily escape into the opening of the tear passage, and the eyes are constantly overflowing. The inflammation may spread over the inner surface of the lids and reach the eyeball; and the constant irritation of the tears, discharge, &c., may also produce ulcers on the front of the ball.

Treatment, if early adopted and persevered in, will readily cure the affection in its first stages. *The crusts must be thoroughly removed* and the lids cleansed. This should be done by means of warm water. To the water bicarbonate of soda (baking soda) may be added, as much as can be lifted on a sixpence to an ordinary tea-cupful of water. When the lids are perfectly clean they should be smeared with ointment of the yellow precipitate.[1] This must be kept up till the lids are quite restored, for the inflammation very readily returns. If the inflammation is very far advanced, the lids thickened and raw looking, &c., after crusts have been thoroughly removed, the edges of the lids may be *lightly* touched all along by a stick of nitrate of silver. In such cases it is also necessary to pull out the hairs seriously affected. As this affection is apt to spread among badly-nourished children, and children not in vigorous health, good diet should be given, and exercise in the fresh air attended to. Cod-liver oil is of great benefit also.

The inflammation can apparently be conveyed to sound eyes by particles of the crusts or matter. Care must, therefore, be taken that towels, &c., used by the sufferer are not used by others, and that hands are well washed after bathing the eyes, &c.

Turning outwards or inwards of the eyelid is frequently a result of the above inflammation. The former is properly called *ectropion*, the latter *entropion*. Injuries, burns, &c., are causes, and the inward turning is frequent as a result of the general laxness of the lid in aged people. The inturned lid grievously irritates the eyeball, against which the lashes rub, and leads to serious inflammation. In the case of the out-turned lid, the inner surface looks red and fleshy from the constant irritation of the air, dust, &c.; and the eyeball being deprived of the protective covering of the lid is also open to irritation by foreign particles, &c. Both conditions can be properly remedied only by sur-

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[1] Yellow oxide of mercury (precipitated) one drachm (60 grains) to one ounce of lard or vaseline.

gical operation. The operation is not at all serious or dangerous.

Stye (*Hordeolum*) is a small boil formed on the edge of the eyelid, occupying the sac of an eyelash. Several are apt to occur one after the other, probably because a bad state of health determines them. They form little red swellings, accompanied by considerable heat and pain. When matter has formed the pain usually ceases. The stye begins usually with an itchiness, producing a tendency to rub the part.

Treatment.—At the very beginning, before the swelling has formed completely, pulling out the lash which passes through the affected part, and then touching the place with a fine point of nitrate of silver, is said to stop its further progress. When, however, it is advanced, warm poultices should be applied, and as soon as matter is formed it should be permitted to escape by opening with a sharp clean lancet. A strong needle will do if it is put in at one side of the little collection of matter, and made to open it up to the other side. A mere prick is not sufficient, since it does not afford room enough for the complete escape of the matter.

If a person is troubled with frequent styes, cod-liver oil, iron tonics, good food, &c., are means of strengthening the person to prevent them.

Tumour of the Eyelid (*Chalazion*) is formed in the depth of the lid. It is sometimes due to the blocking of the channel of one of the glands of the lid, and the gland consequently becomes filled and swollen out by its products having no outlet. The swelling is usually round, pea-like, and often very hard.

Treatment.—When the swelling is softish warm applications, and rubbing in of the yellow ointment (see foot-note on p. 367), are sometimes sufficient to clear it away. When it is hard the best thing is to have it cut out—a very simple and not a very painful proceeding.

Inflammation of the Inner Surface of the eyelids (*Cold-in-the-Eye—Conjunctivitis—Ophthalmia*). This is the common form of inflammation of the eyes resulting from cold. The delicate mucous membrane which lines the inner surface of the lids is called the conjunctiva. As stated on p. 339 it not only lines the lids, but turns up on to the eyeball, which it covers up to the edge of the transparent part in front—the cornea. Consequently, this inflammation affects not only the lids, but also the surface of the eyeball, with the exception of the cornea.

Its **cause** is usually cold; but irritating vapours, the entrance into the eye of irritating substances, will also produce it. It happens in the course of some fevers, specially scarlet fever and measles.

Symptoms. In its simplest form there is redness of the lining membrane, and if the eyelids be examined they present a red velvety appearance. The person feels smarting and heat, beginning generally at the inner corner; the eye is sensitive and watery, and there is a feeling as of sand in it. The person can scarcely keep from winking and rubbing, and believes some sand is in his eye, the removal of which will be sufficient. In more severe cases the redness is more decided; the blood-vessels are seen to be very full and distinct; the lids are swollen, and the loose tissue between the lid and the eyeball is swollen. There is discharge, of a clear sticky character, consisting of mucus, which forms a sort of film and blurs the sight. The discharge dries and forms crusts along the edge of the lids. In the morning the lids are usually glued together with it. These are the symptoms of **catarrhal conjunctivitis.** In still more advanced cases the discharge is profuse and of yellow matter (pus), and we have **purulent conjunctivitis.** The swelling is very great, sometimes so as to overlap the eyeball. This is very serious, and must be carefully attended to lest pustules and ulcers form.

Treatment.—First of all, one must look to see that there is nothing present under the eyelids keeping up irritation and so causing the redness. Incurved hairs will do this, particles of dust, and little white gritty particles that form in the substance of the membrane, are often the cause. If such causes be removed, in simple cases, a mild lotion with which to bathe the eye is sufficient. The chamomile-tea or sulphate of zinc eye-wash is best suited for this purpose (Appendix of Prescriptions—Eye-washes). Let the person give the eyes rest, and freedom from glare of gas-light, &c., for a time. The irritation of tobacco smoke should also be avoided. In the catarrhal form similar treatment is required. The person should bathe the eyes with the lotion so that it may enter the eyes and come into contact with the whole surface. A stronger wash—the bichloride of mercury wash—is sometimes required. (See Appendix.) When the smarting and swelling are considerable great relief will be experienced by taking a pad of lint or muslin, soaking it in the last-named lotion, to which hot water has been added, and binding it on the eye. The puru-

lent form is so apt to produce serious damage to the front of the eyeball, injuring the sight, that the sufferer will display wisdom by seeking at once the advice of a competent surgeon. If that is not at the time possible the treatment recommended above should be adopted and kept constantly in use, every particle of matter being removed as soon as formed. It is not sufficient simply to bathe the eyes on the outside, the lids must be opened so that the removal of matter, that would otherwise lodge, is secured.

Inflammation of the Eyes of newly-born Children is considered under DISEASES OF CHILDREN.

Pustules, the size of a pin's head or millet-seed, are often found in the eyes of ill-nourished children. Usually they are on the edge of the cornea, the transparent part of the eyeball, and look like little raised ulcers. They are called in medical language **phlyctenæ**. Sometimes they surround the edge of the cornea like beads. The lining membrane of the eyeball in their neighbourhood is deeply inflamed, and there is usually considerable pain.

Treatment consists in inserting a piece of yellow ointment (see note at p. 367) into the eye and rubbing it over the pustule by a movement of the lids. To get the ointment into the eye take it on the end of a smooth piece of wood, say the thickness of a match; gently turn out the lower lid and smear it on, then rub the lid over the eyeball. The person's general health ought also to be attended to.

Thickening of the Lining of the Lids (*Granular Lids—Egyptian Ophthalmia—Trachoma*). After prolonged inflammation of the eyelids their inner lining becomes studded by shaggy little elevations, which appear like sago grains, and make the surface very rough. The irritation maintained by the rough lids, as they move over the eyeball, encourages inflammation. The transparent cornea becomes affected, blood-vessels are formed over it, and in the end it becomes so thickened and covered with vessels that the person cannot see with the affected eye. The eye is extremely sensitive to light, and scalding tears are constantly flowing from it.

The **treatment** is of considerable difficulty. The inner surface of the lids should be scarified to destroy the elevations, and then glycerine of tannin should be dropped on the lids, which should be taken between the fingers and vigorously rubbed together. Only a surgeon can do this properly. All the patient can do is to keep the eyes clean and use one of the washes already noted.

Burns of the inner surface of the eyelids, that is of the conjunctiva, should be treated by dropping into the eye a little castor-oil in each ounce of which 2 grains of sulphate of atropia have been dissolved. When the burn is deep the danger is of the inner surface of the lid becoming attached to the surface of the eyeball in the process of healing. In this way the lid may become so attached to the eye as to cover up the ball and prevent sight, and at the same time bind the eyeball and prevent it being moved about to any extent. This condition is called **symblepharon**. Sometimes as the result of burns the margins of the two lids grow together. This is called **anchyloblepharon**.

An operation is required to remedy either condition.

Foreign Bodies within the eyelids. Everyone knows the annoyance and pain caused by getting something into the eye, which has no business there, and which is consequently called a "foreign body." Everyone should be able to look for and turn out such an intruder. First cause the person to open his eye as wide as possible, and turn his eye up as far as possible. Let a finger be placed on the outside of the lower lid to pull it slightly downwards. By this means the lower lid is turned out and the searcher can see if anything is there. If the person turns the eye to one side and another, when directed, the whole surface is readily examined. If any particle is seen it is readily removed by the corner of a soft cloth. If a camel-hair pencil is at hand it is the best to brush out any particles. Next examine the upper lid, which also must be turned out, though that is not so easily done. The person having turned his eye downwards, catch hold of the edge of the lid by the eyelashes, and pull it well downwards and forwards. Put the point of one finger on the top of the lid well under the eyebrow, and turn the lid over on to it. A little practice makes this very easy, but at first it is difficult. If the searcher cannot do this, then let him turn the lid over on the point of a pencil or on the wrong end of a match, &c. If the foreign body is on the lid remove it as already advised. Foreign bodies on the eyeball are spoken of on p. 373. In every case of prolonged irritation of the eyelids a foreign body should be looked for.

Drooping of the Eyelid (*Ptosis*) is a paralysis of the muscle that lifts the lid, which, there-

fore, hangs over the eye and prevents it seeing properly. Children are sometimes born with it. It is sometimes due to affections of the brain. In cases where children are born with the droop, a small operation may be performed for shortening the lid and preventing it overlapping the sight too much.

Inability to shut the eyelid is caused by paralysis of the nerve supplying the lids—the seventh nerve (see p. 96). It is usually accompanied by other signs of paralysis of the face (p. 120).

The **treatment** for the paralysis cannot be discussed here. When, however, the inability to close the lid threatens danger to the eye, by dust, &c., readily falling upon it, and by drying through exposure, it becomes necessary to stitch the two lids together for a part of their extent in order to afford some protection to the eyeball.

Twitching of the eyelids may be a mere peculiarity of an individual or a sign of St. Vitus' Dance (p. 125).

Bruises of Eyelids lead to a black eye. The disfigurement resulting may be partly prevented and, at least, the discoloration made to disappear more quickly by the following method. *Immediately after* receiving the injury, if possible, apply cold water cloths all over the eyelids, and keep renewing them for some time, from a quarter to half an hour. The object of this is to prevent bleeding taking place into the substance of the lids and surrounding parts from small vessels that have been burst; for it is this bleeding that produces the swelling and colour. *After an hour or two* has passed since the injury, apply warm cloths, not too warm, and keep bathing with warm water as long as one's patience will permit. Before going to bed a thick pad of flannel, wrung out of warm water, should be bound over the injured part. The warm applications should be kept up till the swelling and discoloration have disappeared. All rubbing with lotions, arnica liniments, &c., should be abstained from. They do more harm than good; and, on a part badly bruised, are apt to lead to suppuration or sloughing. The hot applications are sufficiently stimulating and promote the removal of the effused blood, &c. *The most utterly wrong thing to do* is to apply leeches or lancet. These draw fresh blood from the vessels, never remove from the part blood already poured out. They make opening for the admission of air, and are invitations to suppuration and death of the part.

Wounds of the eyelids should be treated by a surgeon, since he may so adjust gaping parts as to leave little permanent mark. This is best done in appropriate cases by stitches.

Diseases of the Tear Apparatus.

Obstruction of the Tear Passage. On page 339 the nature of the apparatus for carrying off the tears has been described. The canals in the inner portions of the lids are narrow, and the opening on the edge of the lid small. They are, therefore, very easily blocked. A swollen condition of the lining membrane is quite a sufficient cause of such a blocking; and, since the lining membrane is continuous upwards with that covering the inner surface of the eyelid and part of the eyeball, and downwards with that lining the nostrils and throat, it is liable to share in affections of these other parts. Cold-in-the-head, for this reason, readily extends up the tear passages, producing swelling and increased amount of secretion from the membrane. The obstruction very often begins, not in the canals, but in the tear-sac (p. 339), which becomes affected by the catarrhal condition (p. 154).

Symptoms. The person is troubled with "a weeping eye." The tears gather at the inner corner of the eyelids and run down over the cheek. Especially is this troublesome in cold and windy weather. The nostril of the affected side is dry. Sometimes owing to accumulation of discharge in the sac a small swelling is formed at the inner angle of the eyelids. If the person press with his finger over the swelling it may be emptied, discharge welling up through the tear passages into the eye. The discharge may be clear or mattery. But if the sac cannot be thus emptied the matter is apt to burst its way through the skin at the side of the nose, and a small opening is produced through which matter comes. This is a **fistula** of the tear-sac. *Acute* attacks of inflammation are not uncommon. The inner part of the eyelids becomes red, dry, swollen, and acutely painful, and the inflammation may extend along both lids, so that the eye becomes almost or quite closed.

Treatment is most successful if begun early. Everyone with a "weeping eye" should at once seek competent advice lest this affection be present. A probe is passed along the canal and down through the sac into the nostril. When this is carefully done it is not so painful as

would be expected. It clears the passage and restores the use of the part. But it must be done frequently till the passage is made quite clear and remains so. Hot applications are the appropriate remedy in acute cases, the probing being delayed till the acute attack has passed.

Diseases of the Eyeball.

The cornea or transparent window of the eyeball is most liable to disease, to inflammation, &c. It is plain how serious such affections may be. For, if they involve the cornea to any extent, seeing is at once interfered with, and sight may be practically lost, because this part has lost its transparence, and cannot, therefore, be seen through, while every other part of the eye may be healthy. It is, therefore, necessary that people should be able to learn for themselves whenever this part is threatened, and how, in the event of surgical advice being unobtainable, they may avert the danger.

Inflammation of the Cornea (*Keratitis*) may affect only the surface of the part and be a comparatively simple affection, or it may involve the whole thickness of the cornea and not pass off till it has rendered it untransparent and cloudy and whitish, with permanently lessened sight.

Its **symptoms** are chiefly extreme sensitiveness to light, pain, excessive production of tears, and sneezing when the eyes are opened. The person usually keeps the eye shut, because of the pain light produces. The eye is running with tears, which scald the lids and face. The pain shoots to the temple and eyebrows. Sneezing whenever one attempts to open the eye is due to the action of the cold air on the irritable eye. So tightly does the person keep the eye shut that it is difficult to get a sight of the ball. If one succeeds in seeing it, a red circle of vessels may be noticed all round the margin of the cornea; and perhaps by allowing the light to fall sideways on the cornea, one may be able to see that the surface is not so smooth as is natural but appears ruffled. The other symptoms are so characteristic that they are frequently enough, though the eye cannot readily be seen.

Treatment.—No lotion capable of irritating ought in such cases to be employed. Specially are washes of sugar of lead to be guarded against, since the lead tends to deposit in the inflamed cornea and leave scars that cannot afterwards be removed. Soothing applications only should be employed. Warm cloths applied to the eye are a great relief. A solution of atropine, 2 grains to the ounce of water, should be obtained, and a few drops dropped into the eye once a day. The eye should be closed and a pad of lint secured by a bandage placed over it. A blister the size of a shilling ought to be placed on the temple, where it is left for twenty-four hours, then removed, and the part covered with a piece of lint anointed with oil or fresh butter. The bowels of the person should be kept regular, and good food ordered. Change of air is beneficial. With such treatment recovery should occur in a week or two. It may be mentioned that an inflammation like this may be maintained by the irritation of bad teeth. The teeth should, therefore, be examined and bad stumps extracted.

In the **severer form** of the attack the central part of the cornea is seen to be roughened and cloudy, and the cloudiness spreads over the whole transparent surface, giving it a ground-glass appearance. It is very serious, since it may only pass off to leave the cornea so white that sight is seriously diminished if not lost. The cornea, which in health possesses no blood-vessels, is also liable to become invaded by vessels, which render recovery still more difficult. The inflammation may run on for weeks and months, attacking one eye after the other.

Treatment.—It is specially in children of a very weakly sort that the inflammation is so severe. At its very outset, therefore, attention should be given to the child's health. Cleanliness, good food, fresh air, and cod-liver oil are valuable aids in the treatment. The eye itself is to be treated as directed above. Drops of atropine are to be employed daily; an occasional blister is to be put on the temple; some extract of belladonna is to be made into a moderately thick paint with water or glycerine and spread with a brush over the outside of the shut eyelids, which are then covered with lint, a bandage securing all. Each day the belladonna paint put on the day before is to be bathed off, and more applied. With care this combined treatment will usually be sufficient; but use of the eye is not to be permitted till it is perfectly recovered, and till no trace of over-sensitiveness to light remains.

Abscess and Ulcer of the Cornea are usually the result of injury to the eye—a stroke from a piece of coal, for example; or they occur in persons in depressed states of health. They have the appearance of white spots in the clear

part of the eye. In the case of the ulcer, by looking carefully from the side, one may see that part of the substance of the cornea has been destroyed, and that there is a little hollow on the surface. When the abscess passes deeply into the substance it may open into the anterior chamber of the eye (p. 340), into which matter drops and in which it collects. When this has happened, if the person is made to look up, the yellow matter is seen at the lower border of the transparent part. Sometimes an abscess or ulcer spreads over a large part of the cornea, so destroying it that a large part of it breaks down and separates. In cases where an ulcer has eaten its way through the whole depth of the cornea, it is not uncommon for the coloured part of the eye—the iris—to be pushed forwards and a part of it to bulge through the opening and appear as a little roundish bleb. This is called **hernia of the iris.** When it occurs it seriously delays recovery and injures the chances of a seeing eye being left. After healing and closing of the ulcer the iris remains caught in the scar, and thus the curtain of the eye becomes attached to the transparent cornea in front. Eye surgeons call this condition **anterior synechia.**

The **symptoms** of abscess and ulcer are intense pain, redness and watering of the eye, and on opening the lids the changes going on are quite apparent.

Treatment.—Apply warm cloths. Carefully abstain from using any irritating wash whatever, such as sulphate of zinc wash or sugar of lead wash, &c. Let fall daily into the eye one or two drops of the solution of atropine (2 grains to the ounce). At night paint over the eyelids with belladonna, as directed on p. 371, and let the paint be bathed off in the morning and warm cloths again used. An occasional blister on the temple will help to relieve pain. The person ought to be well nourished, and if in weak health ought to have quinine and iron tonics, cod-liver oil, or syrup iodide of iron (from half to one teaspoonful, according to age). If matter appears inside the eye, an operation must be performed for getting rid of it. Abscesses and ulcers are, however, so serious that from the first a competent surgeon should be consulted.

White spots, opacities, on the clear part of the eyeball, are frequently left as marks of inflammation, abscess, or ulcer. Parents often notice that their children suffer from "weak eyes," as they say—that is, the eyes are red, and watery, and the child avoids the light; but they think nothing of it till they observe "a scum growing over the sight." This simply means that inflammation has been permitted to go on neglected, and the part has lost its transparency and become cloudy. In children something can sometimes be done to diminish the white cloud, but it is not often it can be made entirely to disappear. In grown-up persons these white spots cannot be removed at all. Many people are also under the delusion that the whiteness is caused by something that has "grown over the sight," and can be cut or scraped off. This is a mistake. It is no new thing added to the front of the eyeball. It is simply a part of the cornea that has become white owing to inflammation. If these opacities, as they are called, are to be avoided, it is by having each eye carefully attended to as soon as there is the least evidence of anything wrong.

Treatment.—Bathe the eye with an infusion of chamomile flowers, weakened by the addition of warm water. When the white cloud prevents sight the eye can frequently be improved by an operation for forming an **artificial pupil**, called **iridectomy**, which consists in making an opening in the cornea, passing in a fine forceps, seizing and pulling out a part of the curtain of the eye—the iris—and snipping it off with scissors. An oval opening is thus made in the iris through which light can pass. This is very successful in restoring sight when the opacity occupies the centre of the cornea, leaving a broad clear margin, and when the eye is otherwise healthy. The result of the operation is simply to make a new pupil; and of course the place which affords the most room for this is selected, provided it is in such a position as to be quite uncovered by the lids when the eye is open. Another case also very favourable for the operation is where the opacity is largely one-sided, leaving the other side clear. But when the whiteness extends over nearly the whole of the cornea, no operation is likely to do much good.

Staphyloma is the proper term applied to the condition shown in Fig. 177. As a result of inflammation the cornea becomes cloudy and weakened, and yields before the pressure within. The bulging is often so great that the eyelids cannot close over it. It is very disfiguring, and sometimes it is best to have the eyeball entirely removed. Its presence often is a source of weakness to the sound eye, and on that account its removal is still more desirable.

Foreign bodies in the cornea are very common among miners, iron-workers, and people of similar employment. *Fire in the eye* is the usual phrase they have for such things. If the foreign body is loose within the eyelids, it is to be removed in the manner described on p. 369. But frequently small particles stick in the substance of the cornea, and require removal by means of some sharp instrument. In every large work there is usually one man specially skilful in removing such bodies, but frequently the most some of them succeed in doing is to scratch the cornea in various directions and set up serious inflammation. No one should attempt to remove such a body except with the clearest light. Often when the most careful examination in the ordinary way fails to reveal anything on the eyeball, the use of a large hand lens to focus the light on to the cornea will show the speck. Specially if the person look sideways over the surface, will he see the presence of any irregularity of the surface. Eye surgeons have special lance-pointed needles, set in handles, for removing foreign bodies. The patient sits facing a window, and his head is to be firmly held by someone behind. The operator sits directly opposite the patient, and opens the eye with the forefinger and thumb of the left hand, fixing the eyeball by slight pressure with finger and thumb. *He must never scrape at random*, but cause the patient's head to turn or cause him to turn his eye, so that the light falls in such a way as distinctly to show the foreign body. The needle is now to be deliberately and carefully placed down at the side of the body, and moved so as to turn it out; and this repeated till the object is removed from its fixed position, when the lid moved over the place by the finger may finally remove it. No sudden scratches must be made, one after the other, in the hope that one of them will effect the desired purpose. If good daylight cannot be obtained the person should be set down at the side of a gas bracket, which can be moved to cast the light on the eye in the way best fitted to show the foreign body, and a hand lens used to throw a strong beam of light.

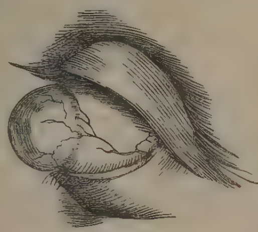


Fig. 177.—Staphyloma of Eyeball.

Wounds of the Cornea are frequent from chips of steel, pieces of coal, &c. Pieces of coal are the worst from their dirtiness. It is of the utmost consequence in such cases to know whether the chip that struck the eye has passed into the ball, or has simply cut the cornea. This is generally made out by shutting the eye and pressing gently but firmly all over the upper and lower lid. If pressure at a particular spot causes a sharp pain each time it is made, the chances are the piece that has struck the eye has passed inwards. If this is so, the eye almost surely will require removal, and that speedily, lest the sound eye becomes inflamed by sympathy (p. 376). Another danger of wounds of the cornea is that, if the cornea is completely cut through, the curtain of the eye—iris—may bulge forward into the wound. This not only delays healing, but serious inflammation may arise from the pinching of the iris in the wound. Wounds of the cornea may also lead to abscesses, ulcers, &c.

Treatment.—Till competent advice can be obtained the eye should be carefully bathed with warm water. A drop of solution of atropine (2 grains to the ounce of water) should be inserted within the lids, which must be very carefully and gently opened for the purpose. A pad of lint should then be applied over the eye, and secured by a bandage pressing just sufficiently to prevent movement of the lids. If pain is great, apply hot cloths over the pad. The atropine may be dropped in twice a day. If inflammation of the sound eye threaten, no time must be lost in seeing an eye surgeon lest both eyes be destroyed.

Inflammation of the white of the eye (the sclerotic, p. 339) appears in the form of a round red swelling, yellowish on the top. It may form a prominence of the size of a pea or small bean. It is to be treated with warm fomentations, and the eye is to be closed, a pad and bandage being applied.

Inflammation of the Iris (*Iritis*). The iris, as explained on p. 340, is the curtain of the eye, whose hue gives the colour to the eye. In its centre is the round opening or pupil. The iris regulates the amount of light admitted to the eye. By contracting it narrows the pupil to a very small opening; and this it does under the influence of much light. By dilating it widens the pupil, and this it does when light is dim, so that more may be admitted. It is, therefore, easy to test whether the iris is in a healthy con-

dition. Shade the eye from light, the pupil should widen; let the light fall full upon it, the pupil should narrow. This test may also be applied by simply shutting the lid of the person whose eye is being examined and then rapidly opening it. On the instant of opening, the pupil is seen to be wide, and it immediately contracts. In dim light a taper may be used and brought near or held close to the eye.

The chief **symptom** of inflammation is the inability of the iris to act under the influence of various degrees of light, or it acts very slowly. This is due to the curtain becoming thickened by the inflammation. Perhaps the first symptom is intense pain, worse at night, so that the sufferer gets no sleep. Light falling on the eye is painful, and the tears flow. But neither of these symptoms is so bad as in inflammation of the cornea. When the eye is carefully looked at and compared with the sound eye, it is found to have changed colour, and is of a greenish, reddish, or yellowish hue. Then the action of light should be tested as already explained. On carefully looking at the eye a circle of fine red vessels may be seen surrounding the transparent cornea.

The **causes** of this inflammation are various. Rheumatism is a very frequent one and syphilis. In inflammation resulting from syphilis it is common to see one or more red fleshy points on the border of the curtain. Cold may also induce an attack.

The **results** of the disease may be very serious. The iris may become attached to the lens behind so as to become permanently fixed. This is called **posterior synechia**. In some cases the pupil becomes altogether closed, causing loss of sight.

Treatment.—Whether one is sure of the true character of the disease or not, the first thing to be done is to let fall a few drops of the solution of atropine into the eye, and to repeat this once or twice daily. This widens the pupil so that if it becomes immovable it is fixed in the most favourable position for sight. If the case is advanced the pupil may not widen at all. This is a sure indication of the nature of the disease. Keeping the pupil wide also keeps it at rest and aids recovery. The eye should also be closed, the belladonna paint (p. 371) applied, as well as a piece of lint and a bandage.

The patient should secure a free movement of the bowels by one or two of the compound blue and colocynth pills. This may be repeated every second night for several times. In severe cases a pill containing 2 grains of blue pill and 1 grain of quinine (for grown-up persons) may be given twice or thrice daily for a week or ten days, unless the gums become sore, when they should be stopped. A blister on the temple aids the purgative medicine in relieving the pain.

When the disease has passed off it may leave a very contracted or closed pupil. After a sufficient time has elapsed—several months—an operation may be performed for the purpose of making an artificial pupil, and restoring some degree of sight by affording a passage for rays of light. The operation is called **iridectomy** (see p. 372).

Cataract is an affection of the crystalline lens (p. 340), by which it gradually ceases to be transparent and becomes more and more opaque. There is no mistaking a case of ordinary cataract. The window of the eye is quite clear, the iris has its usual appearance, but through the pupil is seen the whitish lens. It was called cataract by the ancients, from the Greek verb to flow down, because of the idea that the dimness of sight was due to some watery material flowing down behind the pupil and obscuring the sight. It is caused by some alteration in or interference with the nourishment of the lens. It is commonest in old people from the general failure due to age, a large number of cases being in persons over forty years of age, and the largest number in persons over sixty. In diabetes (p. 303), a disease profoundly affecting the nourishment of the body, it is very common. It is also caused by interference with the lens through accident. Any injury of the eye, which has affected the lens, is likely speedily to lead to cataract. Children are sometimes born with cataract. In some of these cases the opacity extends over the whole lens, in others it is confined to a small part of the lens, and appears as a white spot beyond the dark pupil.

Cataract usually, in cases of old persons, comes on slowly, so that the person feels a gradually increasing dimness of sight, which spectacles do not benefit. There is no pain, and the loss of sight never occurs suddenly. But as dimness of sight may arise from many causes, only an examination of the eye is sufficient to decide whether cataract or other disease is the cause. When the cataract is complete, that is when the entire lens is quite opaque, so that for all practical purposes the person is blind, the light from a lamp or candle can still be perceived in all directions, and the person can point to its direction if it is moved about.

Treatment.—In favourable cases, that is in

cases where there is no other disease that would interfere with sight though there were no cataract, the opaque lens can be removed by an operation, and good sight restored. Of course after the lens has been removed strong convex glasses must be used to enable the person to read. The favourable cases are known by the person being able to follow the light from a lamp moved in all directions, and to point to its direction. The operation consists in cutting round the margin of the cornea until a sufficient opening is made for the lens to pass through. An instrument is passed through the opening to tear open the capsule which holds the lens. When this has been properly done gentle pressure of the lids urges the lens out. Immediately after the operation the patient should be able to see clearly with the eye. A person desiring this operation to be performed should always place himself or herself in the hands of an eye surgeon of repute, since there are a considerable number of risks (to the eye only) that attend the operation. For example, if undue pressure be exerted on the eyeball, not the lens only but some of the vitreous humour behind it may be pressed out. If much of this escapes the sight of the eye will be lost. The operation, therefore, requires skill and delicacy. As soon as the lens has been removed the eye is closed with plaster and a bandage, and the patient is put to bed and kept lying quietly on the back in a dark room for several days. If all goes well the bandage is not undone for four or six days, and it is at least a week before the person is permitted to get up, and several weeks before he is permitted to begin gradually to accustom the eye to light.

An old operation, called **couching**, consisted in passing in a needle and with it pushing the lens out of its place to leave the pupil clear. The lens was thus left in the eye; but it was so apt to set up inflammation by its presence in an unusual position that this operation has been abandoned.

For this operation chloroform is not at all necessary. Indeed surgeons prefer not to give it if the patients are old enough to keep still.

In children the lens is soft, and cataract, when complete, is dealt with in them by passing a needle through the cornea, and through the capsule of the lens, and stirring up some of the soft lens so that it escapes into the chamber behind the cornea—the anterior chamber of the eye (p. 340). It is gradually absorbed there, and after some weeks, when all evidence of the operation has disappeared, the process is repeated with another portion of the lens. In about three months, by repeated operations, the lens disappears, and sight is restored.

Diseases of the Retina (p. 341), **Choroid Coat, and Optic Nerve** are numerous, and are the causes of serious defects of vision and of blindness. It is useless to consider them in this work, since their detection requires an oculist. Some features regarding them may be mentioned. Very serious disease may exist in the deep parts and at the back of the eye without any evident symptom. The sufferer is aware of something wrong from failing sight, which he in vain strives to benefit by spectacles. **Inflammation of the retina** (*retinitis*), **inflammation of the choroid coat** (*choroiditis*), **inflammation** (*neuritis*) **and atrophy** (*wasting*) **of the optic nerve** are the names of some of these affections. They arise from many varied causes. Exposure to cold, changes in the blood such as exist in anæmia and in syphilis, diseases of the brain, and many other causes operate in producing such affections. It is of the utmost importance to observe that excess in spirituous liquors and in tobacco not infrequently leads to failure of sight from changes in the nervous structures of the eye. For such cases total abstinence is the only treatment. In women too prolonged nursing may induce weak sight from affection of the retina and optic nerve.

Separation of the Retina (*Dropsy of the Retina*). In this disease fluid is poured out between the retina and choroid coat at the back of the eyeball (p. 341), with the result of partly separating them from one another. The retina is caused to bulge forwards, at least that part of it behind which the fluid is. Blindness more or less complete, according to the extent of the separation, results.

Treatment of various kinds has been tried with indifferent success. An operation was proposed many years ago for passing a narrow knife through the coats of the eyeball to reach the seat of the dropsy, in order that the fluid might be permitted to escape. A method practised by Dr. Wolfe of Glasgow has in proper cases been remarkably successful in restoring good sight to eyes previously practically blind.

Glaucoma is the name given to a disease which affects every part of the eyeball and ends in complete blindness. The chief feature of it is that the eyeball becomes of a stony hardness. It sometimes comes on quickly in an acute

form, sometimes it creeps on slowly. The disease occurs in old and weak persons, sometimes from exposure to cold, sometimes apparently from fright, and from other causes.

The **symptoms** of the acute attack are violent neuralgic pains in the eyeball, brow, and temple, and perhaps vomiting. Dimness of sight comes on rapidly. The patient sees rays of colour round the flame of a lamp, candle, or gaslight. The eyeball, as already mentioned, becomes very hard. In chronic cases there are only occasional attacks of neuralgic pain, and the eyeball gradually becomes of a stony hardness. In time other changes occur in the cornea, lens, &c. In advanced cases the pupil has a greenish look; hence the name *glaucoma*, which means green tumour.

The **treatment** commonly adopted is the performance of the operation of iridectomy, noted on p. 372. It was first suggested by the distinguished German oculist, Von Graefe.

The **ophthalmoscope** is the instrument by means of which the deep parts of the eye can be examined, and the condition of the nervous coat at the back ascertained. It consists of a small mirror on a handle. The mirror is slightly concave (hollowed). It is held in front of the eye of the examiner, and in its centre is a small hole through which he looks. The patient sits opposite the examiner. Behind his head and to the side is a lamp producing a bright light. The examiner catches the light on the mirror and throws it through the pupil of the eye he is looking at through the small hole in the mirror. The back of the eyeball is illuminated, just as one might illuminate a room by throwing a strong beam of light from a bull's-eye lantern through an opening in one wall. The use of the instrument requires practice; for, unless the examiner's head is in the direction of the light reflected from the eye, the pupil will appear black and he will see nothing. As soon as he catches the light coming back from the eye, he sees a red glow from the back of the eye, and by gradually bringing his eye with the mirror in front nearer, he at last reaches the position from which he sees the opposite wall of the eyeball. The optic nerve entrance, the blood-vessels passing over the retina, &c., are seen, the condition of the humours of the eye is perceived, and one familiar with the healthy appearance can make out change from disease. The instrument was devised by Professor von Helmholtz, now of Berlin. The mirror may be used alone, or with a doubly convex lens.

Foreign bodies within the Eyeball are unfortunately very common among workers in coal, iron, steel, &c. Striking with sufficient force the chip of steel, &c., pierces the coats of the eyeball and passes to the inside. The piece may lodge in the iris, from which it may sometimes be removed with the wounded part of the iris by the operation of iridectomy (p. 372). If it lodge in the lens this ~~body~~ speedily looses its transparency, and may be removed with the foreign body by the operation for cataract. It may lodge in the back chamber among the vitreous humour, or in other situations from which it cannot be removed. Sometimes it may be seen by means of the opthalmoscope. In many cases the person is not sure whether the foreign body that struck him passed in or simply wounded the eye in flying past. In such cases if pressing over the eyelids in one particular spot produces a sudden sharp pain, the probability is the body is within the ball. Inflammation arises, severe pain is felt, the sight grows dim, &c. The danger is of **sympathetic ophthalmia** arising. This is inflammation occurring in the sound eye through nervous communication with the injured one. It is extremely serious. If the slightest sign of it arise, the injured eye should be removed without delay, even though it be yet a seeing eye, in order to save its fellow.

Rolling Eyeballs (*Nystagmus*). This is a continuous rolling movement of the eyeballs, which are constantly shifting about. It is seen in children, the corneæ of whose eyes have lost all their transparency owing to inflammation, and perhaps is due to their seeing the light and continually endeavouring to gain clearer vision. Various other diseases of the eyes, affecting vision, produce it. Among miners cases of it arise by no means seldom. In them it appears to be induced by long-continued work underground in the dim obscurity of a flickering lamp. It gradually becomes associated with nervous disease of the eyeball. Little can be done for it. But a young lad who has already worked some years underground, and shows signs of it, should at once be persuaded to change his occupation and take to something above-ground in the ordinary light.

Squint (*Cross-Eyes — Strabismus*) has been mentioned on p. 350. It is usually due to one muscle having a greater pull than another, so that the balance between them is lost. It may, however, result from paralysis of one muscle,

by a blow, for example, the opposite muscle thereby gaining the advantage. There are several kinds of squint, the two chief being inward or convergent, and outward or divergent. It has been shown that inward squint, in a large majority of cases, is dependent on long-sightedness, and outward squint on short-sightedness. Outward squint, however, is not so common as the other variety. Of convergent or inward squint Stellwag, one of the greatest of authorities on eye affections, says it "is frequently developed at a very early age in children, whose attention is often and continually attracted to small objects situated near the eyes, to whom picture-books and similar playthings are offered for amusement, which demand clear and distinct vision at short distances. As a rule, however, inward squint first makes its appearance at the commencement period when children go to school, when children are compelled for hours to read, write, and engage in similar occupations. . . .

"Everything that increases the necessity for focussing also increases the tendency to squint. In so far insufficient illumination, dark rooms, bad care of the child during the occupation, &c., may favour an occurrence of the strabismus."

Now when squint exists, whether in one eye or both, the two eyes cease to act in harmony, and one of the chief benefits of seeing with two eyes — binocular vision (p. 350) — no longer exists. Moreover, supposing one eye only to squint, it invariably happens that the sight of that eye is largely discounted, is disregarded. Were that not so, seeing that the two eyes do not agree, objects would appear double, but by disregarding the sight of the squinting eye single vision is retained. The result of continued disregard, however, is that the squinting eye loses its sharpness of sight, its vision becomes blunted. Anyone may learn this for himself by causing a person with a squinting eye to look at an object, first with one eye and then with the other, and he will find how dulled the squinting eye has become.

The treatment for squint is twofold. In the first place, with children the causes leading to squinting must be done away with. They should not be required to look long at objects so small as to require much focussing of the eyes; their reading, writing, &c., should be taught in well-lighted rooms. If the child is quite young when the tendency shows itself it will be well to cease instruction of such kinds, of knitting, &c., for a time. When the child is old enough, glasses to correct the long sight should be obtained. It is also a good thing, when there is but one squinting eye, to have the sound eye closed up by means of a bandage for fifteen minutes several times each day, in order to compel the use of the erring one. Of course such procedure is useless unless the other steps already described have been taken. Should these measures fail an eye surgeon would probably propose an operation. It consists in cutting the muscle of the side to which the eye is pulled. It is a simple operation, not requiring chloroform in grown-up persons. It is desirable to do it early, if it is certain other measures fail, before the eye has been blunted from disuse. The muscle is, by the operation, detached from its position. It slips backwards for a little distance, and in course of time attaches itself to a new part of the eyeball. In effect the muscle is lengthened, so that it no longer has the pull over its fellow on the opposite side. Even when this has been done, providing spectacles to correct any long or short sight that may be present ought not to be neglected. In grown-up persons its main benefit is the correction of an unpleasant feature. To girls this is always of moment.

Affections of the Sense of Sight.

Short-sight (*Myopia*) and **Long-sight** (*Hypermetropia*) have been explained on pp. 346 and 347. For the former the treatment is doubly concave spectacles, for the latter doubly convex spectacles, which any optician can supply. Care should be taken *never to get concave spectacles too strong*, else the short-sighted eye is converted into a long-sighted one. Persons cannot suffer from any degree of short-sight without being aware of it. They cannot recognize a friend at any distance nor read a sign over a shop door on the opposite side of the street from them. But long-sighted persons see well at a distance. If they are only slightly long-sighted it is only when they come to look at near objects that the defect occurs. But when the error is slight, persons may not be aware of the long-sight, so effectually does the focussing serve their purpose. But they are continually focussing to see objects which ordinary eyes perceive without any alteration of the lens; thus their apparatus for accommodation of the eye (p. 345) is continually in use and becomes strained. The person may go on for years unaware of this. By and by, however, the person begins to feel an undue strain on his eyes with reading, writing, drawing, &c. His

eyes ache with any prolonged use. They look red and watery after work. After reading for a time the letters run together. He shuts his eyes for a moment, and then on opening them he can read a little time longer, till the letters again run together, and so on. It is easily seen, therefore, how giving a short-sighted person too strong glasses, and converting him by them into a long-sighted individual, makes matters worse.

A short-sighted person is likely to improve as age advances. The lens becomes flattened, does not converge the rays of light so strongly, and therefore the degree of short-sight diminishes. As years pass weaker glasses often suffice.

Weak Sight (*Asthenopia*) is as often due to a slight degree of long-sight as to anything else, and the remedy for this should be tried.

Defective Sight from Age (*Presbyopia*—Greek *presbus*, an old man). With advancing years the lens loses its elasticity, and consequently its degree of convexity undergoes less change than in youth. It also becomes flatter. Near objects are not so readily focussed. As age grows, persons find themselves less and less able to read and do fine work with the unaided eye. Happily convex spectacles readily restore the former distinctness of vision, if nothing else is at fault with the eye.

Astigmatism is a curious defect of the eye, first observed by Thomas Young. It is due to the cornea having different degrees of curvature in different directions. Usually the vertical meridian is more curved than the horizontal. The result is that rays of light passing through the vertical meridian will come to a focus sooner than rays passing through the horizontal meridian. Consequently, all the rays from an object are not brought to the same focus, and the object appears blurred. All eyes have this defect to a slight extent, to such a slight extent that it is not noticed. But let anyone draw a perpendicular line on a black board with chalk, let this line be crossed by another at right angles, and let the person, standing at a distance, look at the point where the two lines cut one another. Looking at this point steadily he will find that he sees both lines, but one more distinctly than the other, showing both are not focussed at the same time. Of course one usually moves the eyes rapidly over objects looked at, and forms the idea of them from successive glances, without being aware that the whole object is not distinctly perceived at one glance. It is only when the defect is excessive that persons become aware of it. The error is corrected by the use of glasses ground from a cylinder; ordinary glasses are ground from a sphere. Such spectacles are plane in one direction and concave or convex in the other. The glass is so placed that the direction of the curve is placed over the meridian of the eye requiring correction, and the degree of the curve is so arranged that by its means the cornea is made practically equally convex in all directions. Short-sight or long-sight is often associated with astigmatism, so that special spectacles require to be made which shall correct the long or short sight and the astigmatism as well. It is often a matter of very considerable difficulty to determine the degree of the defect, and the decision as to the sort of glasses required is often a very tedious process. Astigmatism is very commonly inherited.

Blindness may be due to many causes, loss of transparency of the cornea (p. 372) or lens (p. 374) preventing the entrance of light, diseases of the choroid, retina, or optic nerve (p. 375), affections of the brain, &c.

Amaurosis and Amblyopia are old words, used to express, the former total blindness, and the latter dimness of sight. They were used before the causes of such conditions could be ascertained; but as these conditions are now referred to affections of retina, optic nerve, &c., the old names are being dropped.

Partial Blindness (*Hemiopia*) of an eye, with which nothing seems wrong, may occur. The person, looking straight at some one standing in front of him, sees only one half of him. Half of the retina is blind. This may begin in one eye, but extend to both, the vision of a corresponding half of each retina being lost. It is due to disease of the optic nerve roots. Syphilis is frequently the cause.

Night-blindness (*Hemeralopia*) is the result of a blunting of the sensitiveness of the retina owing to some excessive irritation. It has its origin in the long-continued action of strong light upon the eye, and is also connected with weakness of the nervous system. The retina may be blunted by the strong glare from snow; and this may occur to those who walk over fields of snow or ice among the mountains, without having the eyes protected by a dark veil or dark glasses. This is called **snow-blindness**. Similarly, **moon-blindness** is a like condition, produced among sailors in the tropics who sleep on deck under the full light of the moon.

Colour-blindness (*Daltonism*). This affection was called *daltonism* because it was first described by John Dalton in 1794. Colour-blindness, however, exists in several forms. The form to which the term "daltonism" is properly applied is a lack of sensibility to red. Red light and red objects appear greenish or greyish. Since, according to the theory explained on p. 351, the sensation of colour is a mixed sensation, dependent upon the excitement of three sets of nerve fibres, one set sensitive to red, another to green, and a third to violet, an excitement of all three in a definite proportion producing the sensation of white, and in various other proportions, the sensations of the other colours,—since this is so, the loss of sensibility to red will affect not only the perception of red but all other perceptions in which the sensibility to red has any great place. Thus the sensation of yellow is due to moderate excitement of the fibres sensitive to red and green, and feeble excitement of the fibres sensitive to violet. Consequently to the person not at all sensitive to red the whole character of the sensation is altered. The fibres sensitive to green are moderately excited; there is no response to the red, and the violet is feebly excited. Thus yellow appears a decided green; red is confounded with brown and green; violet is called blue, and rose-colour is not distinguished from blue.

Besides insensibility to red there is a similar lack of perception of green—**green-blindness. Blue-blindness** is another form in which blue and green, and blue and yellow are confounded.

Red-blindness is the most common. It is inherited, as a rule, and dates from birth, and is commoner in men than women. The best test is to give the person a handful of variously-coloured wools and ask him to place all of one colour together.

In rare cases colour blindness is complete, and the person recognizes only blacks and whites.

Double vision is the result of paralysis of some of the muscles of the eyeball. The affected eye cannot be moved round in a particular direction as far as its neighbour; the correspondence between the two eyes is therefore lost, and at that point the object looked at appears double. In other directions of the eyeballs the vision is single. It is the result of tumour or other affection of the brain, such as arises in the course of syphilis. Other causes also may induce it. Accompanying it there are probably other signs of paralysis, droop of the eyelid, dilated pupil, &c., and perhaps some paralysis of the face.

DISEASES AND INJURIES OF THE EAR AND AFFECTIONS OF THE SENSE OF HEARING.

In the first part of this section the division of the organ of hearing into external, middle, and internal ear, has been described. All these parts may be attacked by disease, and all are more or less capable of treatment. It is only, however, the diseases affecting the external ear, chiefly the external canal, that can be reached by anyone who has no special knowledge. No disease of the ear, no matter how apparently trifling, should be neglected. An inflammation, beginning in the canal, may pass to the drum, pierce it, and go on to the middle and internal ear, ending in partial or complete deafness. Most cases of acquired deafness are due to such inflammation, which destroys the part of the ear designed for conducting sound, so that though the internal ear may remain healthy, it is deaf because sound cannot reach it.

Diseases and Injuries of the Ear.

The Auricle or external appendage of the ear is liable to injuries, to wounds, and bruises. These must be treated as any other wound or bruise in the manner indicated in the section on ACCIDENTS AND EMERGENCIES. It is also liable to skin affections, specially eczema. The treatment for this is described on page 318.

Inflammation of the Canal of the Ear—Boils in the Ear Canal. A boil in the ear canal is often caused by irritation from the use of ear-picks or by cold. It is sometimes a sign of a depressed state of health. A general inflammation without the formation of a boil may also arise from similar causes, or attend the progress of measles and scarlet fever, or result from injury.

Symptoms. There is pain in the ear—ear-ache—more or less intense according to the degree of inflammation. Movements of the jaw increase the pain as a rule. Hearing is diminished, and noises in the ear are troublesome. On looking into the ear the swelling of the boil may be seen—if it is not too far in—and the skin around it is red. If there is no boil but a general inflammation, the walls of the canal are reddened and swollen. The canal is also occupied in such a case by discharge, which finds its way to the outside. The ear may go on discharging for a week or two; but, if the case becomes chronic, it may last for a long time. In

the case of a boil, when matter has formed and the boil bursts, great relief is experienced, and the affection, as a rule, speedily passes away.

In the chronic form of the general inflammation there is not much pain, but there is usually some deafness, accompanied by noises in the ear. A constant sense of moisture in the ear is the chief sign, or it may be a continued flow of matter from the ear. The discharge may cease in warm weather to return again with cold, and so it may continue, if not attended to, even for years. The evil of this is that it leads to thickening of the walls of the canal, and is certain to extend to the drum and the middle ear. It may cause piercing of the drum, and may even continue its way inwards till the membranes of the brain become affected, death resulting.

Treatment.—Warm poultices should be applied over the ear and side of the head. Warm water poured from a spoon into the ear canal and allowed to remain for a few minutes is very soothing. In the case of a boil nothing relieves so much as a cut with a fine knife. This of course can only be done by a surgeon. If none is at hand the poultices and warm water must be used. In general inflammation, when the discharge appears, it should be carefully and gently washed out by syringing with warm water. The canal should then be carefully dried as far as possible with cotton-wool, and a piece of dry cotton placed in the passage. When the discharge continues for more than a week, the canal should be syringed with warm water and dried; then half a teaspoonful of a solution made by dissolving 4 grains of sulphate of zinc in 1 ounce of water should be dropped into the ear, allowed to remain for a few minutes, and then caused to flow out, the canal being afterwards dried and closed with a piece of dry wool. A solution of 2 grains of chloride of zinc to a quarter of an ounce of glycerine and three quarters of an ounce of water may be used in the same way. In *each case the solution should be warmed* before being dropped into the ear.

At the beginning of every acute inflammation of the ear a brisk purgative, salts or seidlitz powder, should be given to the patient. In weakly persons good nourishing food and tonics will greatly aid recovery.

Wax in the Ear to excess is a frequent cause of deafness. As we have mentioned on p. 356 wax is produced by glands in the canal, and its presence keeps the walls from being unduly dry. It may be present in excessive quantity either because it accumulates or because it is too freely produced. The irritation of cold, &c., will cause excessive production, but nothing does so more readily than the constant irritation of a pin or other substance used to pick the ear. Many people are in the constant habit, when washing, of twisting up a corner of a towel or other cloth and pushing it as far as possible into the canal to clean it. Others use a small sponge on a stem for the same purpose. *All such methods should be abandoned.* The cleansing of the ear by the ordinary routine of washing and drying with the finger covered with the towel is always sufficient. The other methods only succeed in pushing the wax more deeply in and blocking the canal.

Symptoms.—A gradually increasing deafness may be the only sign. Noises, buzzing, rushing noises, &c., may be heard in the ears. Giddiness is a rare symptom, and can only occur when the accumulated mass presses unduly on the drum or parts of the canal. The collection of wax may be considerable without any marked degree of deafness, and the deafness may come on quite suddenly. This is due to the canal, which has hitherto never been quite closed, suddenly being quite blocked by a small piece of wax, or by swelling of the mass already there owing to the entrance of water. Pain is not common, though it may arise from the pressure of hard masses.

Treatment.—The wax is, as a rule, easily removed by syringing. A glass syringe may be used capable of holding not less than an ounce. Care should be taken that its nozzle is blunt. A few turns of cord wound round the wide end will enable one to hold it, when in use, without risk of slipping. A bowl of warm water is used, in which a quantity of soap sufficient to make the water feel soapy has been dissolved. The syringe is worked several times to see that it is in order. The patient sits sideways to the operator, who takes the ear between the finger and thumb of the left hand and pulls it gently backwards and upwards. This helps to straighten the canal. The end of the full syringe is placed in contact with the *roof* of the canal, *just inside its opening—not pushed far in*, that is to say—and the water injected in a steady gentle stream, *never forcibly.* The process is to be repeated till all the wax is removed. Sometimes it comes away in large plugs, moulds of the canal. A bowl is held below the ear to catch the water as it escapes. As soon as all the wax is removed the syringing should be stopped. Surgeons usually have a mirror for directing light up the canal to enable

them to see when the passage is quite clear. Any person may use a small hand-glass for this purpose, reflecting the light up the canal, which is straightened by pulling the ear upwards and backwards. If this is properly done the whole length of the canal is visible in the ears of most persons, and the white glistening drum is seen at the end. At least any person with moderate skill may see whether the canal is still occupied by the dark-brown masses of wax. When the syringing ceases, the canal is dried, and a small piece of cotton placed in it and kept for a day only. No drops of any kind are needed. In all cases where the presence of wax has not set up other changes, and when the ear is otherwise healthy, improvement of hearing should immediately follow removal of the wax, though some buzzing noises will remain for a short time, as a result of the injecting.

Growth in the canal of the ear (*Polypus*). Growths are commonly the result of the irritation of discharges. They are soft red masses hanging from the walls of the canal, and may be no bigger than a pin-head or large enough to fill the canal. They cause deafness, and perhaps pain from pressure. They require cutting out.

Foreign bodies in the canal may be of very various kinds—beads, peas, small stones, insects, &c. Small bodies like beads may exist for a long time without producing any symptoms other than slight deafness and noise in the ear. If they are large, their pressure causes pain, and is liable to set up inflammation and discharge. A small pea may occasion such disturbance by swelling up with moisture and coming to press on the walls.

Treatment.—Syringing with warm water in the manner described for the removal of wax is the only safe method that unskilled persons should adopt for dislodging them. If this fails a surgeon should speedily be consulted. Much injury may be done ignorantly by trying to extract the body with pins or other instruments.

Inflammation of the Drum of the ear results from the action of cold, cold water, or is due to injuries, to the pressure of masses of wax; foreign bodies, &c. Violent syringing for the removal of wax may set it up.

Its chief **symptom** is pain, often very severe, and worst at night, preventing sleep. Coughing and sneezing aggravate the pain; and in serious cases sickness and giddiness may be present, specially in children. Deafness, and noises in the ear, attend it. In children some degree of fever is commonly present. Ulceration and piercing of the drum is a consequence of the disease. If this is not properly attended to, permanent deafness may result.

Treatment.—It is of great moment that the case should be treated by a qualified person. The only treatment an unqualified person should undertake is the application of warm poultices to the side of the head, and the dropping of warm water or warm oil into the canal of the ear. A strong dose of medicine, salts, seidlitz, &c., is useful.

Injury to the Drum is occasioned sometimes by the accidental pushing too far of a knitting-pin or such instrument with which the wax of the ear is being picked out. The membrane may be burst by a blow flat on the ear, by the explosion of artillery, or in the act of diving. It is, in these cases, caused by the sudden and strong condensation of air in the external canal.

The accident is indicated by a loud crack in the ear, by sudden severe pain, giddiness, and noises in the ear. Deafness immediately follows. Some blood may flow.

Treatment.—The ear should be closed by cotton wool. Nothing else should be done unless inflammation arise, which is treated as mentioned above.

Inflammation of the Middle Ear need only be mentioned here. It has many forms, is very common, especially in childhood, and is the common cause of deafness. One of its forms frequently arises in scarlet fever; another form is the chief cause of "running ear." In its chronic form it tends to extend inwards to the membranes of the brain, thus causing death.

In acute cases pain is the first symptom. Children are very restless with it and feverish. They scream when the ear is touched. Giddiness and sickness is common; delirium and convulsions may attend it. Usually the parts behind the ear are very sensitive to pressure. In chronic cases there may be no pain, the chief element being the constant discharge.

Treatment in acute cases must be prompt and effective. The danger is so great that no delay should be permitted in summoning a surgeon. Till one can be obtained a strong dose of opening medicine should be given, and repeated if necessary; the patient should be confined to bed in a quiet room; and hot poultices

should be applied over the side of the head, or a blister immediately behind the ear. Chronic cases require the ear to be continually kept clean by syringing, as described for removal of wax.

Earache attends all cases of acute inflammation of the ear, whether it is the external canal, the drum, the middle ear, or other parts that are affected. The presence of foreign bodies causes it; while, again, it may be a form of neuralgia, or due to the irritation of a bad tooth.

The general **treatment** consists in applying hot poultices to the side of the head, and in gently pouring warm water or oil into the canal. A good application is made by filling a soft flannel bag with chamomile flowers, which have been steeped in hot water, and using it as a pillow.

Discharge from the ears (*Running Ears*) has been sufficiently referred to under INFLAMMATION OF THE EXTERNAL CANAL, and INFLAMMATION OF THE DRUM and MIDDLE EAR. It ought never to be neglected, and all the more should it be carefully attended to if it has been long standing. It is an ignorant mistake that anything but good can arise from the stopping of a discharge as the result of appropriate treatment. If it stop of itself it may be because of some obstacle to the escape of the matter; and then naturally the pent-up fluid may quickly produce the gravest mischief. Parents and guardians who pay little heed to the "running ears" of their children are guilty of a very grave neglect of duty, and are morally responsible for any evil that may and is only too likely to arise.

Affections of the Sense of Hearing.

Deafness is a symptom of most affections of the ear. It may be due simply to accumulation of wax. If it come on suddenly without pain, in a healthy person, this is probably the cause (see p. 380). When it comes on with a cold in the head, and a sense of "stopping in the head," it is the result of the cold (see CATARRH, p. 154), and is likely to pass off in a few days. Attended by pain, ringing in the ears, &c., some degree of inflammation is likely present (see p. 381). The most intractable form of deafness comes on very gradually and painlessly, and is connected with disease of the middle ear. Usually, also, it has gone on increasing for years before advice is sought. If a skilled ear-surgeon were consulted early enough, much might probably be done to stay its progress. The sudden loss of hearing caused by bursting of the drum, as the result of violence, will pass off as the tear in the drum heals.

Deafness due to disease of the nerve of hearing is usually very intense, comes on suddenly or advances very rapidly, and is not easily reached by treatment.

Noises in the ears are present in nearly every ear disease, but they are worst in diseases of the middle ear. They readily pass off in the affections of the external ear and drum when these diseases abate, and their treatment is that of the particular affection of which they are a symptom. The chance of their being got rid of, when they are occasioned by disease of the middle or internal ear, is small.

Deaf-Mutism.

Inability to speak is in a large majority of cases the result of deafness. A person, who cannot hear either the voices of others or his own, has no inducements to utter words, and thus becomes dumb. It is naturally during childhood that this is specially shown. A child who has become deaf, as the result of disease, speedily loses the power to use language of which he had not yet obtained any mastery. A grown-up person, to whom the use of language has become a matter of habit, would not so lose the power of it, though he might lapse into silence, more or less complete according to the degree of deafness.

Children may be born deaf and thus never in the ordinary course of things become able to utter the sounds of articulate speech. In a large number of cases, however, the deafness is the result of disease arising in the course of childhood.

The **causes** of the congenital form of deaf-mutism, that is of the form dating from birth, cannot be stated with certainty. It is important, nevertheless, to observe that intermarriage, the marriage of blood relations, is held to play a very serious part in the production of the defect. For example, it has been estimated that 10 per cent of the deaf in the United States of America are the offspring of parents nearly related. It is not necessary that the children of deaf-mute parents should also be deaf-mute; but the risk is considerable that they will be so, especially if both parents are deaf. This applies,

however, only in those cases where the deafness of the parents arose before birth, and not where it has been the accidental result of some disease of childhood. The causes of deafness arising after birth are numerous. Scarlet fever is one of the commonest because of the disease of the ear so rarely absent from this fever (p. 381). Next in order of frequency as a cause is disease of the brain, some form of meningitis (p. 100), or water in the head (p. 102), measles, typhoid fever, whooping cough, mumps, scrofula, inflammation of the lungs, diphtheria, and accidents of various kinds.

Treatment.—It is sometimes the case that a child, apparently deaf, possesses some slight degree of hearing; and, in a few cases where the deafness is the result of some acquired disease, something may be done to improve the hearing. It is, therefore, of great consequence that parents should early detect defects of hearing in their children and promptly seek skilled advice. Where the degree of hearing is slight, parents are too apt to conclude that it is useless to attempt to train the child in the ordinary way, and to allow it to grow up as if it were absolutely deaf, teaching it by signs only. When the child can be made to hear by loud distinct speaking, close to its ear, the parents ought to take the utmost pains to teach it in this way, and ought to make use of signs as little as possible in order to enable it to acquire a knowledge of words.

There are two methods of teaching deaf-mutes, one by means of signs and by the manual or finger alphabet, called the French system, and the other by lip-reading and articulate speech, or the German system. The manual alphabet for two hands is usually employed; but it is adapted also for one hand only. In lip-reading and speech the deaf-mute is taught to put his vocal organs into the positions by which the various sounds are produced, and to understand what is said to him by the position of the lips, mouth, &c., of the person speaking to him. This method has been attended with very considerable success, so that on leaving school the deaf-mute is able to converse with his teachers, family, and intimate friends, on ordinary subjects. In rare cases the deaf-mute is able to converse freely and easily with strangers. The time required to attain moderate proficiency in lip-reading and speech is ten or twelve years, and the child should begin to receive instruction early, at the seventh year of age if possible.

A system of signs for instruction in lip-reading and speech has been designed by Prof. A. M. Bell of England, and extended and developed by his son Prof. Graham Bell of New York, the inventor of the telephone.

The modern system of caring for and educating deaf-mutes has shown that deaf-mutism is not necessarily associated with any degree of mental or moral defect. In some cases the defect is undoubtedly associated with feeble-mindedness, and is only one evidence of impaired development, but it is not necessarily so. With deafness one great avenue of the mind is closed up, and, if no effort is made to supply its place, the intelligence must suffer from want of development. If pains are taken to open up other avenues, it is abundantly shown that in the large majority of cases education becomes as effective as if supplied through the channels of hearing.

The Care of the Eyes and Ears.

The Care of the Eyes. A common-sense rule should be applied to the eyes and ears as to other organs. We know that excessive use of a muscle produces a sense of tiredness, and that the sensible course is to give the muscle rest for a season. The eye may also be tired with much work, and on signs of fatigue showing themselves the organ should be rested. Some persons cannot read or write or otherwise use the eyes for close work without a feeling of pain and stiffness. This is often due to some degree of redness, and perhaps inflammation, of the lids; but it is more often a sign of some amount of long-sightedness. Persons who suffer in this way should, therefore, have their sight tested. Spectacles for reading or fine work may be found completely to relieve the feeling.

In reading or writing, or in similar occupations, the head should not be allowed to hang down and forwards. This position prevents the due return of blood from the head, and is bound to produce some discomfort if nothing else. The way in which light falls on the work is of importance. It should come from the side, but so that the arm or hand may not intercept it. It ought not to be allowed to fall upon the face and eyes, or in any way to produce dazzling. The light ought to be sufficiently clear to render the work, writing, reading, &c., quite distinct without need of peering. Direct sunlight is bad, and so is a very brilliant artificial light. A mellow light, such as is given by a good reading-lamp, is best. Above all, the light should be steady and not flickering. For this reason much reading in railway carriages, or under similar

circumstances, where complete steadiness is impossible, is injurious.

Under certain circumstances it is necessary to shade the eyes. In driving against a strong wind, for example, the eyes should be protected lest inflammation of the delicate membrane (conjunctiva), lining the lids and part of the eyeball, be set up. For the same reason persons should guard against sitting in a railway carriage by the side of an open window, facing the direction in which the train is going, if there is any wind. The eyes should also be protected from the glare of a bright sun reflected from calm water when sailing, from similar glare reflected from white pavements in cities, and specially from the glare of the sun reflected from fields of snow. Spectacles of plane smoked glass are best for these purposes.

Special care should be taken with the eyes of children in the directions already indicated. They should not be allowed to read too long at a time; the table or desk at which they sit should be of a height to keep the head erect, and should be placed in the position referred to as regards the admission of light. Books printed in clear bold type should be placed in their hands so as to avoid straining their unaccustomed eyes, one of the most frequent causes of squinting (p. 376).

The Care of the Ears consists mainly in avoiding the use of pins, &c., for picking out wax. The necessary cleansing is sufficiently performed by the little finger or the corner of a towel. Wool should not be worn in the ears except when specially needed. It may be placed in the ears before entering water to bathe, and should be removed on coming out. Avoidance of vigorous nose-blowing will aid in preventing water that may have entered the nostrils from passing up the tube from the throat to the middle ear (eustachian tube, p. 356). No discharge from the ear should be left unattended to for a single day after its appearance (see p. 382).

Section XIII.—ACUTE INFECTIOUS DISEASES: FEVERS.

INFECTION AND CONTAGION.

Formerly a distinction was drawn between diseases that were *infectious* and those that were *contagious*. The word infectious used to be employed in a vague way to imply the nature of a disease that could be communicated to a person without any apparent introduction

of poisonous material into his body, a disease that somehow was about in the atmosphere; while a contagious disease was one which required the direct passage of the unhealthy stuff causing the disease into the body. This distinction has been broken down, and infection and contagion are now known to mean practically the same thing. The answer to the question of what exactly they do mean, opens up one of the most interesting and most recent chapters of medical science, a general account of which may be given.

About the middle of the seventeenth century one Anton Leeuwenhoeck lived in the town of Delft, in Holland, as the steward of a judge there. He was accustomed to employ his leisure in making little lenses wherewith he magnified and examined the structure of such things as butterflies' and gnats' wings. He had great skill of hand, and made several hundred lenses, each one to suit some particular object he wished to examine. With such a simple instrument, in April, 1675, did Leeuwenhoeck reveal a new and hitherto unsuspected world of living things. He placed under one of his simple microscopes a glass of rain-water, and perceived a multitude of variously-shaped bodies darting to and fro. Further experiments showed their presence in various organic (that is animal and vegetable) infusions. Hence these animalculæ, as their discoverer supposed them to be, have been termed **Infusoria.** But whence came they? Was it true, as the philosophers of antiquity believed, that organic substances, decaying animal and vegetable matter, with sufficient air and moisture, could, under the influence of heat, beget anew living things? Could "the sun breed maggots in a dead dog, being a god kissing carrion?"

Now it so happens that, thirty-seven years before Leeuwenhoeck's discovery, a similar question had been distrustfully put by a physician of Florence, François Redi, and had been triumphantly answered in the negative. Redi was not satisfied that the sun could "breed maggots in a dead dog" or in any other kind of dead meat, and he put the question to the test of an experiment as simple as it was conclusive. In hot weather he placed some fresh meat in a jar whose mouth he then covered with gauze, and in another but uncovered jar he placed a similar piece of meat; and he observed that while the exposed meat speedily swarmed with maggots, that under cover, though it became stinking, remained free of maggots. The maggots were not, therefore, the products of putrefaction, but their true cause was speedily apparent. For he noticed that multitudes of flies buzzed about the gauze, on which maggots were bred from eggs deposited there by the flies. The maggots were then not the products of dead organic matter, subject to heat, air, and moisture, but the direct offspring of living things. Could this explanation be applied to the infusoria of Leeuwenhoeck? and were they also hatched from eggs, or in some way the offspring of preceding infusoria like unto them? This was a much more difficult question, and not, at first sight, capable of a test so simple as Redi's. Moreover, other observers flocked to the new field of investigation opened up by the microscope; the simple microscope was improved on; and, as the instrument became more and more powerful, smaller and still smaller living things came into view, till some were clearly revealed that would appear as mere points under Leeuwenhoeck's simple lens; while the modern compound microscope now discovers others as invisible to the simple lens as the infusoria are to the naked eye. The problem to be answered does not alter with the diminution in size; the same question is raised, Whence come they? In every organic infusion left standing for a day or two, more or less as the weather is cold or warm, in every organic infusion they swarm in myriads. Are they begotten by the mere breaking down, the decomposition, the putrefaction, the death and decay of the organic substance, or are they developed from eggs or in some other way the direct offspring of ancestors like themselves? Another very simple experiment seemed to settle the question, an experiment devised in 1748 by an English Catholic priest named Needham, in association with the French naturalist Buffon, but only perfectly carried out seventeen years later by an Italian philosopher, the Abbe Spallanzani. Its purpose was the same as Redi's, to keep an organic substance so that nothing could alight on it from without, in order to find whether, under these conditions, living things could develop within it. So minute are the organisms, however, that multitudes might be deposited unseen from the air during even a moment's exposure. With great ingenuity were the altered circumstances met. It was argued that heat would destroy the organisms, as it destroyed other living things. So an organic infusion was placed in a flask and boiled, and after it had been boiled for some time the neck of the flask was sealed by melting it in a flame, so that any living thing in the flask must have been killed and no fresh supply

could enter. When this had been properly done no animalcules ever appeared in the flask. The experiment is open to criticism. When one boils the infusion, the steam with which the flask is filled drives out the air, and by sealing the neck none can enter. It may be that living things can be spontaneously developed from organic infusions, but only in the presence of air, and the experiment has excluded air. In more ways than one was this criticism answered. In 1854 two German observers, Schroeder and Dusch, boiled organic infusions in flasks, but instead of sealing the neck of the flask they simply plugged it, when the steam was issuing from it, with a firm plug of cotton wool. As the infusion cooled, air entered the flask, but was filtered on its way by passing through the wool. These infusions developed no living things. Than this even a more remarkable demonstration was given by the great French chemist, Pasteur, in 1862. He used a flask having a very long neck with a very fine bore. When the infusion was boiling he bent the neck downwards by the aid of heat. Air could freely enter, but it must pass upwards, not downwards. Any solid particles present in the air could not ascend with it, and so the air when it reached the infusion was free of them. In these flasks also no animalculæ were developed. But a second ground of criticism remains. It might be said, it is possible that an organic infusion which, before being boiled, might have been capable of spontaneously giving rise to living things, has been rendered incapable of doing so by the boiling, not because the heat has destroyed any eggs, seed, or other living thing from which a progeny could have been developed, but because the heat has somehow altered its constitution, just as heat will take the temper out of a spring. This too is easily answered. Break off the sealed end of the flask and leave the flask open but undisturbed, or remove the cotton-wool plug; in a few days the flasks, which for months, or for years may be, have remained free from putrefaction, swarm with life. Or as Pasteur did, drop a small fragment of the wool plug through which the air has been filtered into the infusion, within hours it is alive. Without doubt, then, the microscopic life that decaying animal substances contain in exuberant prodigality is not the outcome of some rearrangement of the particles of the dead matter, but is the product of previous life. But these and similar experiments reveal another fact—organic substances or fluids treated as in these experiments not only remain free from animalculæ but exhibit no sign of decay, no evidence of decomposition, no symptom of putrefaction. But let fall into the fluid from the point of a needle, or insert into the organic substance, a tiny speck of matter in which a microscope has exhibited animalculæ, at that point putrefaction begins, from that spot it spreads, decomposition wherever the organisms have contrived to push their way, no taint whatever in the spot to which they have as yet been unable to advance, but speedily pervading and permeating the entire fluid or solid till it is one mass of corruption. Thus, just as Redi showed, that by excluding the blow-flies dead meat ceased to breed maggots, even so later experimenters have shown that by excluding the air, or rather by purifying it from the eggs or seeds, or whatever they be which throng in it, and which it sows on all it comes into contact with, by excluding or purifying the air the dead meat will likewise cease to stink.

This gives a very brief historical summary of the various stages in the discovery of new realms of life, whose inhabitants, though themselves invisible to our eyes, yet obtrude themselves by their ravages before our senses in various offensive ways.

They and their ways must now be described in some more detail, since their significance in men's lives is even more wide and appalling than experiments up to a comparatively recent date seemed to indicate.

The name infusoria was applied to the organisms discovered by Leeuwenhoeck, but the much more minute living things rendered visible by more powerful lenses were up to a late period all classified under the term Bacteria, which is a Greek word (*baktērion*) meaning a little staff.

Their excessive smallness is beyond one's power to imagine. Under the highest power of improved microscopes, which magnify about 4000 times, they appear like the periods and commas of ordinary type. If a man could be magnified by the same amount he would appear as huge as Mont Blanc or Chimborasso. In comparison to the size of an ordinary man a bacterion is as a grain of sand to Mont Blanc.

Workers with the microscope were not long in discovering that even among these smallest forms of life there was as great variety as among higher and larger forms. Indeed differences which they manifested were too great to permit them to be placed all together as members of the same class or order. Various classifications have been proposed for them, which it

is unnecessary to state here. It is desirable, however, to note and remember several of the chief types. The differences which exist between them are largely in size and form, to

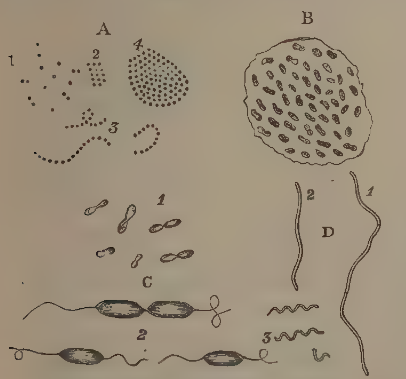


Fig. 178.—Various species of Micro-organisms.

A. Micrococcus: 1, singly; 2, in groups; 3, in chains; 4, in mass. B. a mass of Bacteria (Zooglœa mass). C. Bacteria: 1; singly, constricted in the middle, as about to divide into two; 2, shows, in a much more highly magnified view, the way in which one bacterium divides into two, each half passing off as an independent form. It also shows the flagella, or lash-like tails, of the bacteria. D. 1 and 2, Vibriones; 3, Spirilla. All are very highly magnified. (After Klein and Dallinger.)

some extent in mode of multiplication. In one thing they all agree. They all consist of a kind of protoplasm, a jelly-like substance resembling white of egg, which is clear and transparent, without any indication whatever of separation into organs, but exhibits sometimes minute bright particles of oil. The protoplasm is inclosed by a membrane formed of cellulose, capable of resisting the action of acids and alkalies.

All the various kinds are grouped together as **micro-organisms** (Greek, *mikros*, small), **mycrozymes** (*mikros*, and *zumē*, yeast), or **microphytes** (*mikros*, and *phuton*, a plant). **Bacteria** is also a general name for the group, but the term is now also applied to the particular kind, for which it is better to reserve it.

The **Micrococcus** (*mikros*, and *kokkos*, a berry) is one form. It is round, and sometimes no larger than the 32,000th of an inch. It grows after a fashion common to the other forms. The body becomes narrowed in the middle, as if by a band tied round it. The constriction increases until the single round body is almost divided into two. In a brief time the connecting thread is severed and the organism is completely split into two, each of which now has an independent existence. In a short time each one of the two divides, so that from the original *one* there are now produced *four*. This process of multiplication is called **fission**. In Fig. 178, A. are shown micrococci, some of them singly, others in groups, some in chains, and one large mass. The various kinds of grouping are due to their rapid multiplication in the manner described. The large mass is held together by a fine transparent material in which the organisms are imbedded.

The **Bacterium** is another kind of micro-organism. It is rod-shaped, about $\frac{1}{10,000}$th of an inch long, and a third less in breadth, and it has rounded ends. It multiplies like the micrococcus by dividing. The process is shown in Fig. 178, C. At 1 is seen a number of bacteria shaped like the figure 8 by the dividing process. At 2 is shown the process much more highly magnified. This part of the figure shows also that the bacterium possesses a thread-like tail at each end. By lashing movements of the threads the organism can move about in fluids. When the division of one into two is almost complete, only a long thread connects the two halves. This finally breaks in the middle, and each half moves away as an independent being, as shown in the figure. Besides growing in numbers in this way, Dallinger has shown they may multiply in another fashion. He has watched two bacteria meet and become fused together into one mass, losing their tails and becoming motionless. After a time the mass looks very granular. Finally it bursts, and there pours out a cloud of exceedingly fine particles. After watching the cloud of particles for some time Dallinger saw fully formed bacteria issuing from it. In fact the particles were spores or seeds, which, in a sufficient time, with the aid of heat, moisture, and nourishment, developed into the adult forms. This is **multiplication by spore formation**. In two ways, therefore, bacteria multiply.

The **Bacillus** is a third form of micro-organism. It also is rod-shaped (Latin, *bacillum*, a

Fig. 179.—The Bacillus of ordinary putrefaction.

A. 1, single bacilli; 2, bacilli forming threads and developing spores. The bright oval body in the centre of each bacillus is a spore. B. 1, ordinary form without spores; 2, with spores; 3, free spores; 4, a mass of spores. (After Klein.)

little rod). It is larger than the bacterium. Bacilli are particularly apt to form long chains or threads, being strung on end to end as they increase in numbers. They increase both by

division and by spore formation, like the bacteria. Fig. 179, A. 1, shows three bacilli. At 2 is seen a chain. In the body of each bacillus is seen a bright oval dot. This represents a seed or spore. It increases in size at the expense of the jelly-like material forming the substance of the organism, till it bulges out the inclosing membrane. At last the membrane bursts, and the spore is discharged. If it is surrounded by nourishing material it will develop into the full-grown bacillus. If not so favourably placed it may still retain its vitality. In fact spores may be exposed to all kinds of unfavourable conditions—to cold or to heat; they may become dry and be dispersed as dust. But let this apparently lifeless dust be brought into favourable conditions of moisture and warmth, with nourishment at hand, and forthwith the spores will grow, and adult forms will be produced from them in abundance. Fig. 179, B. shows bacilli with spores, and a mass of spores.

The **Vibrio** (Fig. 178, D. 1 and 2) is a rod-shaped, and wavy or jointed organism. It moves about by rapid wave-like motions.

The **Spirillum** is the last form that need be mentioned here. It is represented in Fig. 178, D. 3.

All of these, we have seen, multiply by one of two ways, either by division or by the formation of spores, but the rapidity of their increase is beyond conception. In one brief hour, under favourable conditions, one may perceive the whole progress of their life history. Here is a comparatively simple calculation, but one whose results are so enormous that the authority of one of the most distinguished of investigators is given for its accuracy, that of Prof. Ferdinand Cohn of Breslau. Given that one bacterium will divide into two in one hour, then each of these two in another hour will divide, making 4, after three hours there are 8, and so on. At the end of 24 hours from one bacterium there are developed $16\frac{1}{2}$ millions (16,777,216). After 48 hours the number amounts to $281\frac{1}{2}$ billions, and after 3 days to 47 trillions. Into a flask containing a clear, transparent, organic fluid, and under favourable conditions, sow a drop of water containing but one bacterium, and such as this is the result. Nevertheless the multiplication is not indefinite; it is indeed strictly limited. It is from the contents of the organic solution that the bacteria obtain the nourishment for their life and growth. As soon as they have exhausted the nutriment they can no longer multiply, and will speedily cease to exist.

Accompanying their multiplication changes take place in the clear fluid which are quite visible to the naked eye. It becomes muddy, turbid, and loses its transparency. When the bacteria have exhausted the nourishing material, they fall to the bottom as a deposit, and the fluid may become again quite clear, but altered in constitution, because its complex constituents have been rent asunder to supply food to the organisms.

Now two questions arise—questions which have been already alluded to in the historical sketch given on pp. 385, 386, and the answers to which have been also indicated, but questions which must be again referred to. They are these: What is the origin of these bacteria? and what is their relation to putrefaction, from which they are never absent? To each question there are two answers: to the first, as to the origin, the old answer is expressed by the phrase, "spontaneous generation;" that is to say, organic substances may give birth to them under certain conditions of heat and moisture; the modern answer is, They have always parents like to them. To the second question, their relation to putrefaction, one answer is, They merely accompany it; the other is, They cause it, and without them it cannot be. Now, in spite of experiments like those of Schroeder and Dusch, men of high scientific attainments held and yet hold the view of spontaneous generation. It does seem absurd to believe that one cannot expose anything to the atmosphere for a single instant without there being deposited on it invisible particles of dust, including seeds, spores, or germs of bacteria or bacteria themselves, which await only a favourable opportunity to develop and attack, if it is liable to attack, the substance to which they have adhered. But this apparent absurdity, by a series of beautiful experiments, was shown by Prof. Tyndall to be a fact. Everyone knows that if a room be darkened by closing the shutters, and if a beam of sunlight be allowed to enter by a chink or crack in the shutter, its track will be revealed by myriads of dancing motes that catch the light and disperse it. The track of a beam of the lime or electric light will be shown in the same way. But for these dancing particles of dust the light would only light up the object on which it fell, its pathway would be invisible. Tyndall constructed a chamber whose top, floor, back, and sides were of wood, and whose front was of glass. In the floor were openings through which test-tubes were passed, their mouths opening into the chamber. A strong beam of light

was thrown into the chamber, its path being clearly visible owing to the dancing particles. The chamber was then allowed to stand undisturbed; and three days later, when a beam of light was again thrown into it, *its pathway was invisible.* This showed that the air was perfectly free from suspended particles, which had all attached themselves to the sides or fallen to the bottom of the chamber. Into the test-tubes an organic fluid, capable, therefore, of decomposition, was carefully poured through an opening in the roof. The projecting ends of the tubes were allowed to dip into a bath of brine, which was boiled for 5 minutes. The bath was then removed and the chamber allowed to remain. For months it stood, the fluid showing no signs whatever of putrefactive change, while the fluid in similar tubes, subject to the same treatment, but standing in the open air of the laboratory, rapidly decomposed. But a few days after the chamber had been disturbed, so as to raise the dust, the fluid in every tube gave way and was found to swarm with bacteria. Experiments with all sorts of infusions gave precisely similar results. Moreover, Tyndall showed that air strained through cotton wool or heated by passing through a red-hot tube no longer revealed the pathway of a beam of light—was deprived, that is, of solid particles, thus explaining fully how air admitted to flasks plugged with wool did not produce decay in any organic material in the flasks. In truth these and multitudes of other experiments show convincingly that the air is everywhere laden with solid particles, including germs which, sown on suitable soil, rapidly multiply, their multiplication being accompanied by all the stages of putrefaction. They exist everywhere, but more thickly spread in towns than in the country, becoming fewer as one recedes from human habitations, but they are present, nevertheless, in the atmosphere far removed from human dwellings, on the heights of the Alps as in the most densely-peopled valleys.

It is by the French chemist, Pasteur, however, that the most complete and brilliant series of experiments was performed that disposed of the theory of spontaneous generation.

He was led to these experiments by studying the action of yeast. Leeuwenhoeck had noticed little round bodies in beer, and in 1837 Cagniard Latour had observed that the fermentation of beer was accompanied by the growth of these little bodies. They are called torulæ, and are not bacteria. They are round or oval, and multiply by budding. But Pasteur proved that the fermentation was the expression of the active life of this small cell; that, to obtain certain materials requisite for its nourishment, it attacked the sugar present in the fluid, and as a result of splitting it up produced carbonic acid and alcohol. From the fermentation of beer he passed to the butyric and lactic fermentations—actions whose results anyone may see by watching the process of the souring of milk. He demonstrated that in each case the fermentation was the work of an organism introduced from without. The production of vinegar he showed to be also the work of a bacterium. Introduce yeast into beer-wort, it grows and flourishes, and alcohol and carbonic acid gas are formed. But the yeast soon exhausts the material on which it grows, and immediately its own activity ceases. But it has not exhausted the capacity of the liquor to nourish various other kinds of living things. This is the golden opportunity of bacteria, which may then become active, and by the fermentive process they in turn set up beer becomes sour. Beer, vinegar, and wine in turn received Pasteur's attention, and in each case he separated the living agent, different in each, whose growth was the direct cause of the change. Let bacteria foreign to the fermentation proper in each case be introduced, and beer becomes sour, vinegar becomes flat and tasteless, wine is converted into vinegar. These questions were inextricably interwoven with the wider one of spontaneous generation. This Pasteur also attacked by means of such experiments as have been indicated, though not in their historical order, and which Tyndall's experiments, performed later, amply verified, so that Pasteur was able to declare: "There is not one circumstance known at the present day which justifies the assertion that microscopic organisms come into the world without germs or without parents like themselves. Those who maintain the contrary have been the dupes of illusions and of ill-conducted experiments, tainted with errors which they knew not how either to perceive or to avoid. Spontaneous generation is a chimera."

But many observers have taken organic infusions—an infusion of hay, for example—have boiled them in flasks, duly sealed the necks, and have laid them aside, and yet after a sufficient time bacteria have been found in them multiplying. Such results have been obtained by the most experienced observers, when no doubt existed as to the experiments being well conducted. The explanation in due time was forthcoming. The fully-developed bacteria are

destroyed by a temperature much below that of warm water, not so their spores. These seeds, or eggs as one may call them, resist the temperature of boiling water, prolonged even for several minutes, and in some cases even for hours, so that, when set aside, by and by the boiled infusion will give way owing to the growth of the eggs to the fully active bacteria. Indeed they are unusually resistant, defying the action not of heat only, but also of extreme cold. One may freeze the solution containing the bacteria, one may keep them for hours at a temperature many degrees below zero, the bacteria themselves die, but their spores are only dormant, and will awake up to life soon after the usual temperature is restored. Drying they successfully encounter as well as the action of many chemical agents.

Thus one objection after another has been set aside, till it becomes conclusively evident that there is present in the atmosphere a vast number of germs of various kinds, each kind capable of setting up a fermentation peculiar to itself, that putrefaction is only one kind of fermentation, the expression of the life and growth of a particular germ whose activity liberates from the organic substances on which it lives sulphurous and other badly-smelling gases, and that, if by any means the organic substance is kept free of the living things, it will not putrefy, will not break down, but will remain in its organized though lifeless condition.

From this point of view the germs of putrefaction cease to be mere interlopers, parasites, breeders of corruption. They come to occupy a recognized and legitimate place in the constitution of nature. Nay, not only do they fill a recognized place, but they discharge a necessary function, they play indeed a beneficent part in the drama of life. The world of lifeless matter consists—let it be put roughly and broadly—of a number of elements, carbon, oxygen, hydrogen, nitrogen, sodium, potassium, phosphorus, sulphur, &c., associated together in various ways, oxygen and hydrogen as water, oxygen and nitrogen as atmospheric air, potassium, sodium, phosphorus, in various combinations as salts of various kinds. Now these substances are just such as plants, the lower animals, and man require for their nourishment. But neither the lower animals nor man can take these inorganic substances and convert them into the living matter of their bodies. A diet of phosphate of lime, chloride of sodium, and potassium, charcoal, and so on, with a liberal allowance of air and water, though containing the same elementary substances as are found built up into muscle, nerve, and bone in a human body, is but as the sand of the desert to a hungry man. Six feet of earth may be a liberal allowance for his grave, but not for his repast. Not so with the plant. From the earth in which it is rooted, from the air to which it stretches its arms, it draws just the same elements as have been named, and builds them up into much more complex forms, into highly-organized substances. On these complex combinations of the same original elements animals and man can live. The ox crops the herbage and builds up in its own body into still higher forms the organic substances the plant yields to it; and man in turn derives nourishment from the substances the plant and the lower animal prepare for him, composed though they be of the same materials which, as beggarly elements, are practically valueless for him. And now what would happen, suppose there was ever a building up and never a breaking down? The plant, which is the first workman in nature's great manufactory, which performs the first stage in the process of converting the raw material into the finished article, the plant cannot live on boiled mutton, nor yet can it feed on the bodies of its dead companions. It is the elements it seeks. But if it is perpetually building up the elements into organic substances its own supply of nourishment will some day be exhausted, it will cease to live. If balance is to be maintained, the process by which organized bodies are broken down into elements must keep pace with the process by which elements are built up into organized bodies. Death is necessary to life. This breaking-down process the lower animals and men to some extent accomplish. A man eats bread and meat, he takes into his body complex substances, he transforms them into material for his use; they abide in his body for a longer or shorter time, give him the means of obtaining heat and energy, and are then cast out, as carbonic acid gas, water, urea, and salts—practically restored, that is to say, to their elementary form, broken down from their complex state. But animals and men die. Their bodies are masses of complex, organic substances, in that form useless for any practical part in the cycle of life. But now to sweep away this useless mass an invisible host of busy workers descends from the air, who take possession of the body, send detachments far and wide into its inmost recesses, and rest not day nor night till they have rent asunder from one another the wondrously piled molecules of

albumen, of fat, of nerve, of blood, till they have broken down the walls and torn from one another the stones of the tabernacle of flesh—till they have restored again to earth and air that which years before the plant took from them. No putrefaction without organisms; and thus life presides over the work of death.

Now, these facts that have been stated supply the foundation of the modern view of infection and contagion. The resemblance between fermentations and putrefactions and various diseases, specially those of an infectious or contagious sort, had long ago been remarked; and if the one set of occurrences was the work of organisms or germs, why not the other? Why not? In 1850 a French doctor, Davaine, on examining with the microscope a drop of blood from a patient who had died of splenic fever, observed little thread-like bodies about twice the length of a blood corpuscle. He paid little heed to his discovery. But in 1863, excited by the proof Pasteur had meanwhile offered of organisms of a similar nature being the cause of various fermentations, he made new observations, and found the same thread-like body constantly present in the blood of sheep and rabbits dead of the disease. These are the first definite observations that link contagious diseases to the life and growth of germs.

Now it so happens that about the same time ruin was threatened to one of the industries of France, that of silk culture, by the presence of a mysterious disease among the silk-worms that spread like a plague not only in France, but in Spain and Italy as well. In 1865 the loss to France by its ravages amounted to over four million pounds sterling. No measure that could be thought of seemed of the least value to stay its progress. In the distress the government of France turned to Pasteur, who had taught the French wine-growers how to prevent disease in their vines, and besought him to render his assistance. He visited the affected districts, and was speedily able to affirm that the disease was due to the presence in the insects of minute cylindrical bodies about $\frac{1}{6000}$th of an inch long, and therefore only discoverable by the microscope. These microscopic organisms had been observed years before by an Italian naturalist, Filippi; but whether they had any connection with the disease was not known. Pasteur proved they were the cause of the disease, and that it was contagious. He showed that if a silk-worm, in whose body the round bodies were present, was pounded up with water in a mortar, and the poundings painted with a brush on the leaves on which healthy worms were fed, they would all without fail be smitten with the plague. For three years he worked at silk-worm disease, and succeeded, with grievous injury to his own health, in unearthing its precise nature and in devising means for its arrest, by the adoption of which prosperity was restored to this industry. During this time, and for some years after, a hot discussion had been going on about Davaine's discovery of bacilli in splenic fever. In 1876 a young physician living near Breslau, Dr. Koch, published a paper giving a full account of the life history of the splenic-fever bacillus, and a complete demonstration that its introduction into the body of animal or man was the only cause of the disease. In the following year (1877) Pasteur, driven into the question of contagious diseases by his experiments on beer, wine, and silk-worm diseases, investigated the question, and confirmed and extended the results of Koch. Now what of splenic fever? It may attack the horse, the cow, the sheep, and man. In some years France lost by it in cattle from a half to one million pounds sterling. It is rampant, not in France only, but in Spain, Italy, Russia, and Egypt. It has appeared in this country, *transported from Russia by hair.* It is sometimes called *wool-sorters' disease*, because in this country it has been chiefly wool-sorters that have been attacked by it. The evidence is conclusive that the hides had been those of animals dead of splenic fever. Some of the blood of the animal containing the germ that is the cause of the disease, had soiled the skin and the bacillus had produced spores. These seeds had clung to the hairs, and in spite of drying had retained their vitality. In the process of sorting they had been detached and had gained entrance to the bodies of the sorters by the breath or in some other way.

It is worth stating what is the general method adopted in investigating the nature of micro-organisms. By the use of very highly magnifying powers, and by the use of staining agents, they can be seen under the microscope. In the blood of an animal dead of splenic fever an organism was discovered by means of the microscope, but no information could thus be gained as to its relationship to the disease. Often, moreover, various kinds of such living things were found, and the question arose which kind, if any, was it that produced the disease. Experimenters, therefore, attempted to grow artificially the different organisms. Some flourish and multiply in chicken-broth, others grow

well on gelatine, some on raw potatoes, while various other solids and fluids were found capable of nourishing them. Experiment showed, moreover, that a particular form of organism flourished so well in one particular fluid that, though this kind with many others were put into a flask of the fluid, the particular form took entire possession of the fluid, and no other had a chance of life against it. Here, then, was a method of sifting out one kind from another until a fluid, containing one form only, was obtained with which to experiment. Thus a drop of blood taken from an animal dead of splenic fever is placed in a flask containing meat-broth, which has been shown to be free of germs of all kinds by having stood for several days or weeks, after being boiled, without the least trace of decomposition occurring in it. The flask is plugged with wool, and is maintained at a certain heat. In a few hours the bacilli of splenic fever, present in the drop of blood, have multiplied enormously. If other kinds of organisms were present in the drop they may have grown too, but to a less extent, because the soil, so to speak, is not so suitable for them. From this flask a drop of fluid is taken and transferred to a second flask containing the same pure broth free of germs. The special bacillus multiplies here again, other forms less. From the second flask a drop is transferred to a third, and so on through six or seven flasks, till a fluid is obtained containing the one particular organism only, all the others having died out. This flask now contains what is called a **pure cultivation.** Now if the bacillus contained in this fluid is the cause of splenic fever, then the injection of a small quantity of the fluid into an animal, capable of taking the disease, ought to produce the disease in the animal. If it produces the disease, then in the blood of the animal the same bacillus should be found, and from a drop of the blood new quantities of the organism ought to be capable of being reared, by means of which, in turn, the disease can be again communicated. All these different processes must be gone through before it can be said with perfect certainty that the particular germ is the active cause of the particular disease. Besides all this, it is plain that when a cultivation of the germ is obtained, experiments may be performed to determine what substances hinder and what aid its growth, whether carbolic acid, Condy's fluid, or other agents, kill it, and so on. By such means information may be gained that would enable the disease to be arrested or stamped out.

A remarkable illustration of this may be given from Pasteur's work. He found that hens never took splenic fever, and that the disease could not in an ordinary way be communicated to them. Now a degree of heat equal to 44° Centigrade kills the splenic-fever bacillus, and the heat of hen's blood is 41° or 42°. He thought perhaps the high temperature of the fowl's blood prevented it from taking the disease. So he took a hen and placed it in a cold chamber till its bodily heat was lowered to 37°. He then injected the poison; it took the disease and died. He did the same with another fowl; but this time, at the height of the attack, he placed it in a warm chamber to raise its bodily heat up to or above the usual. It recovered. But, again, Pasteur found that an animal, that had recovered from one attack of splenic fever, was safe from a second attack. He found that he could cultivate the splenic bacillus through hundreds of generations without its violence being the least affected, provided one cultivation followed another within an interval of hours. If, however, a cultivation of the organism were left for days or months with a due supply of pure air, its violence was remarkably diminished, and *if this weakened bacillus were injected into an animal the animal was very slightly affected for a short time, but was rendered incapable of acquiring the fatal form of the disease.*

Pasteur announced his discovery; he was offered a test and accepted. In May, 1881—probably many remember an accouut of the experiment in the papers—in the presence of veterinary surgeons, agriculturists, and others, a flock of 50 sheep and 10 cows were brought before him. Into the bodies of 25 sheep and 6 cows he introduced some fluid containing the weakened germ, the remaining 25 sheep and 4 cows were untouched. Three weeks later the most fatal form of the poison was injected into the bodies of all the 50 sheep and 10 cows. Two days later the 25 sheep that had not received the weakened germ were dead, and the 4 cows were very ill, while the 25 sheep and 6 cows which had received it were comfortably browsing. Since that day, up to the end of 1883, more than half a million of animals were vaccinated (so to speak) in France against splenic fever, with a consequent reduction of the death rate from that disease to $\frac{1}{10}$th of what it was among non-vaccinated animals.

Briefly, then, splenic fever has been found to be due entirely to the presence in the body of the affected animal of a particular living organism, and the result of that knowledge has

been to indicate the means for stamping out the disease.

The true nature of another disease, that of tuberculosis, has within recent years been revealed by methods of inquiry similar to those just described, pursued by the distinguished German observer, Dr. Koch. It has been stated (p. 278) that tubercle is the chief cause of consumption of the lungs and consumption of the bowels, and of some forms of inflammation of the membranes of the brain (p. 101). In the little nodules of tubercle (p. 278) Koch found a small organism, a bacillus (Fig. 180). He was able to grow it artificially, and by injecting fluid, containing his reared germs, into animals, he caused them to be affected by the disease. In the spit of consumptive patients the tubercle germ is found. The spores or seeds of the germ are not destroyed by drying, so that when the spit has become dry the seeds may be wafted about in the air, may be drawn into the lungs of a healthy person, may take root and grow and produce the disease. The popular objection, therefore, to sleep with, or be the close companion of one suffering from consumption, is not without scientific justification. On the other hand, the germ of tubercle needs a high temperature for its development, and it is not therefore likely to thrive in the outside world in temperate climates.

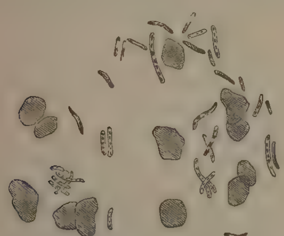


Fig. 180.—Bacilli in Spit of Consumptive Patient.

After the epidemic of cholera in Egypt in 1883, which spread to France, Italy, and Spain, investigations were undertaken to discover whether any special organism could be detected having any particular relationship to the disease. French, German, and British commissioners were appointed for the purpose. Dr. Koch, who was head of the German commission, detected a peculiar bacillus, shaped like a comma (,)—the comma bacillus, in the intestines of persons who had died of cholera, in the discharges from cholera patients, and also in water of which persons had drunk, who had afterwards been seized with cholera. He believed that this bacillus was the active agent in the production of the disease. Animals, however, are not susceptible to cholera, and the essential link in the chain of evidence, namely, the production of cholera in animals by the injection into their bodies of the pure cultivation of the organism, could not be obtained. In 1885 Dr. Klein, the head of the British commission, reported as the result of his investigations his inability to accept Dr. Koch's view. At present, therefore, the relation of micro-organisms to cholera is not definitely determined.

In the blood of persons suffering from relapsing fever another form of micro-organism—the spirillum (Fig. 178) has been found in great numbers, and during the intervals of freedom from fever they disappear from the blood. The fever has been produced in monkeys by injecting into their bodies blood from persons suffering from relapsing fever, and thereafter the spirilla have been found multiplying in the monkey's blood.

A micrococcus (p. 387) has been found in Erysipelas (Rose, St. Anthony's Fire), and the injection of the artificially reared organism into rabbits has produced erysipelas in them.

In the annual reports of the Registrar-General the following diseases are classed as zymotic, that is, as resembling fermentations, and apparently due to some poison operating in the blood, which poison might consist of living organisms such as have been described:—

Small-pox.	Erysipelas.
Measles.	Puerperal Fever.
Scarlatina.	Carbuncle.
Diphtheria.	Influenza.
Quinsy.	Dysentery.
Croup.	Diarrhœa.
Whooping Cough.	Simple Cholera.
Typhus.	Ague.
Enteric or Typhoid.	Remittent Fever.
Simple Continued Fever.	Rheumatism.

Now micrococci (p. 387) have been found in small-pox, scarlet fever, diphtheria, and in the diarrhœa of children, and bacilli (p. 387) have been found in dysentery and typhoid fever, although as yet no definite relationship has been proved between the organisms and these particular diseases. Inasmuch, however, as a micrococcus has been found capable of causing erysipelas, and bacilli of different kinds capable of producing splenic fever, consumption, and apparently cholera, it would appear probable that it needs only patient research, like that of Pasteur and Koch, to reveal the connection between all infectious disease and the growth of micro-organisms. How, precisely, the organism operates in the production of the disease it is

not easy to determine. It seems probable that the multiplying organism produces some chemical alterations in the blood and tissues of the animal attacked, and that the diseased conditions are the consequences of these alterations. The organism may do this by splitting up certain constituents of the blood and tissues in order to obtain what it requires for its own growth; or it may be that, in the course of its own growth and multiplication, the organism produces some special substance, a ferment, for example, and that it is owing to the operation of this special substance, manufactured by the organisms, that the symptoms of the disease are manifested.

These considerations have some very practical issues. Every infectious or contagious disease appears to be due to some form of micro-organism, one particular organism for each particular disease. The germ or organism of scarlet fever can produce only scarlet fever. It can never produce measles nor typhoid fever any more than from corn, sown in the ground, can a crop of potatoes be expected. Each organism produces its own disease and none other; and the special disease cannot arise unless its germ has gained entrance to the body. They may gain entrance in many ways. They may be present, like putrefactive germs, in the air, in food, in drink. They may be received on one's clothes; they may be harboured under one's thumb-nail; a hostess may dispense them with her hospitality; a friend may impart them by a kiss. But, though the channels by which they spread are inexhaustible, *they have one origin and one only*, and that is a preceding case of disease. Germs of measles, of diphtheria, of typhoid fever, can no more develop anew than can germs of putrefaction, which, it will be remembered, are always derived from parents like to them. If typhoid fever germs gain entrance to a person's body they came from the body of some one, whether he can be found or not, who had the fever before him. The organisms enter the body of a person and multiply there. They are cast off from his body, some by the air which be breathes out, some by his skin, some by the kidneys, some by the way of the intestinal canal. One kind of germ may be particularly abundant in the discharges, may be able to multiply in organic fluids, so that the smallest quantity of such a fluid gaining entrance to food or drink is capable of imparting the disease to those who partake. Another kind of germ, on the other hand, may be drowned, so to speak, in liquid, and may rather be propagated by spores suspended in the air. But that is a mere detail in the life history of the germ. In all cases, however, it is the introduction of the bacterium, the micrococcus, the bacillus, or whatever it be, it is its entrance into the body, by whatever channel, that sets up the disease.

This view of infectious diseases thus affords the hope and suggestion of a method of diminishing, if not of getting rid of, such diseases altogether, and to some extent also indicates the direction in which their cure is to be sought. If the particular organism of each contagious disease were known, the condition of its life and activity understood, and the circumstances hurtful to, or destructive of, its life fully ascertained, there is great probability that this knowledge would at once suggest a method by which its multiplication in the living body could be arrested, and the disease thus cured. Even without such knowledge, however, the view indicates the means for arresting the spread of contagious diseases and diminishing their occurrence. The means consist in preventing the spread of the germs from an existing case of disease. Too often, however, one case of a contagious disease is simply the breeding ground of a multitude of other cases, because no steps are taken to prevent the scattering abroad of the germs. To prevent such an occurrence methods are adopted for destroying the disease germs that have proceeded from the patient's body. These methods are stated under DISINFECTION.

Two misunderstandings must be guarded against. In the early part of this article the grounds were stated for the assertion that the organisms of putrefaction were everywhere, and could not be avoided. There can be no doubt that everyone daily swallows and draws into the lungs hundreds of them. These germs of putrefaction are powerless to harm the living human body. Moreover, by no possibility, it would appear, can such organisms be changed into forms capable of acting in a poisonous manner on the living body. To repeat, it is not the ordinary germ of putrefaction that does harm; it is a particular form of organism for each particular disease. The second point to be noticed is that disease germs may gain entrance to a person's body and yet he may not suffer from the disease. Just as in nature each plant grows best in a particular soil, and in some kinds of soil certain plants cannot grow at all, so disease germs may enter a person's body but be unable to thrive there. In other words, the person is able to resist the disease. Just as there are

soils that will grow anything, so there are persons who catch everything that is going.

Nothing gives a man so great disease-resisting power as good health. That man secures himself best against infectious as against other disease, so far as man can secure himself, who, besides keeping far from the source of the infection, lives regularly and temperately in diet and in conduct.

Epidemic and Endemic. It is the fact of contagion that gives the peculiar character to diseases called **Epidemic** diseases. One person affected with small-pox comes into a community. In a short time others catch it from him. Each one of these communicates it to others, and thus the disease spreads among the people. It becomes epidemic (Greek *epi*, upon, and *dēmos*, the people). Small-pox, measles, and scarlet fever are thus types of epidemic diseases, diseases capable of over-spreading a community in a brief period. On the other hand such diseases may appear here and there, not spreading for some reason or another, but an odd case occurring unconnected with others, so far as known. Such cases are said to be **sporadic.** In opposition to epidemic is the word **endemic.** The essence of an epidemic disease, as we have seen, is a poison, capable of multiplying in a human body, of being cast out of the body, and of being passed from person to person, communicating the disease. Now an endemic disease is not one which can be so passed and conveyed from one person to another regardless of place. It is linked with some particular district, so that a person is not liable to it unless he comes within the affected district, and perhaps by leaving the district he may get rid of it. It depends, that is to say, upon some peculiarity of climate, of water supply, or drainage of the district in question. Thus goitre (p. 210) affects persons living in certain parts of Derbyshire, in certain Swiss valleys, &c., and persons will not be affected by it if they keep away from the localities where it prevails. It is not, therefore, epidemic, but endemic.

DISINFECTION.

It has been shown that infectious diseases are communicated from a sick person to a healthy person by material thrown off from the body of the sick person, the active part of the material being probably some form of living organism. It has been seen that the poisonous material may come off from the patient's body in his breath, in discharges from the mouth and throat, from the skin, from the bowels, and from the kidneys. It is desirable that as soon as possible all poisonous material should be destroyed in one way or another to prevent the spread of the disease. All the means employed to accomplish this are included under the term disinfection, and the materials that may be used for the purpose are called disinfectants.

The **disinfectants** commonly used are carbolic acid, chloride of lime, Condy's fluid (which is a solution in water of permanganate of potash), sulphurous acid, obtained from burning sulphur, Burnet's fluid (a solution of chloride of zinc), sulphate of copper (blue vitriol) dissolved in water, and sulphate of iron (copperas), sulphuric acid (oil of vitriol), and hydrochloric acid (spirit of salt).

These substances ought to be used in such a way as to destroy the matter of contagion. There are some substances which, strictly speaking, do not destroy the contagious matter, but simply prevent its growth and multiplication. These are called **antiseptics**; and a good example is carbolic acid in weak solutions. The living matter of contagion cannot multiply when exposed to the action of an antiseptic, but if the antiseptic be removed the contagion may then go on to multiply. Its growth is merely *arrested for the time being*—the living organisms are not killed. There is another class of substances which may remove the offensive smell of decaying matter without killing or hindering the growth of contagion in it. These are **deodorants.** It is a true disinfecting action that is wanted, an action which will kill the contagion, so that neither at the moment nor at any future time can it become capable of doing harm.

The manner in which disinfectants should be employed for various purposes will now be stated.

To disinfect a patient's body. The patient should be kept perfectly clean. His body should be sponged daily with lukewarm water, to which a small quantity of ordinary vinegar (acetic acid) may be added. When scales or crusts are separating from the skin, the body should also be daily anointed with lard, or with olive-oil or glycerine, with every 40 ounces of which one ounce of pure carbolic acid should be mixed. This prevents the scales, &c., being scattered about in the air of the room, and at the same time acts as a disinfectant.

To disinfect nurses' or other attendants' hands, the best method is washing in water made pink with Condy's red fluid, or the permanganate of potash itself, or in water in

every two pints of which 1½ ounces of carbolic acid have been dissolved. *All dirt should be removed from under the nails in the process of washing.*

To disinfect clothes, they should, immediately on removal from the patient, be steeped for at least an hour in water, every gallon of which contains a quarter of a pint of carbolic acid. The acid is, however, dear; in its place water containing two ounces of chloride of lime to the gallon (1 pound to 8 gallons) may be used, and has the merit of cheapness. Care must be taken that only the clean water is used, containing no particles of the lime, which would burn the clothing. To prevent this a wooden tubful of the solution should be made at a time. The chloride of lime should be well stirred with a stick and then left to settle. After it has quite settled the clear liquid from the top can be drawn off as required. After this steeping the clothes should be washed and boiled. Rags and scraps, not to be kept, should be immediately burnt. Articles of clothing that cannot be so steeped and washed, beds, &c., should be exposed to the fumes of sulphur, applied as directed for disinfecting rooms.

To disinfect discharges from the bowel, &c., they should be passed into vessels already containing a disinfecting solution. A cheap one is made by chloride of lime, one pound to the gallon of water. A stock of it should be kept, and some placed in each vessel as required. For the same purpose water, containing oil of vitriol (sulphuric acid), in the strength of one ounce of acid to a gallon of water, may be employed. A mixture used for the same purpose is made of 8 ounces of sulphate of zinc (white vitriol), 1 ounce of carbolic acid, and 3 gallons of water. On the whole, the chloride of lime is as useful as any, and very cheap. Plenty of the disinfectant should be mixed with the discharge. When the whole has been emptied into a water-closet the basin should be well flushed with water, to prevent the disinfectant collecting in the pipes and eating through them. If there is no water-closet—if, for instance, a dry closet is in use, as in the country—the discharge should be received in a vessel containing a solution of oil of vitriol or spirit of salt (of the strength of 1 ounce to 20 of water); chloride of lime should be added, and the whole thrown into a pit in the ground far from all wells or other water supply, and fresh earth thrown upon it. All chamber vessels should be washed in an acid solution, water containing one ounce of oil of vitriol, or spirit of salt, to the gallon.

To disinfect rooms, sulphur or chloride of lime should be used. Windows must be tightly closed, fireplaces and all crevices and cracks properly blocked up. Articles of clothing, bedding, &c., should be hung on lines. An iron vessel is placed in the middle of the room, containing one pound or more of sulphur, according to the size of the room (1 pound for every 1000 cubic feet of space), and, when everything is ready, the sulphur is to be lighted by placing a live coal on it. The door is then tightly closed and left so for 24 hours. Thereafter windows and doors are opened; and the room is freely ventilated for other 24 hours. After this has been done the ceiling should be whitewashed and the walls washed down. If the walls are papered, the paper should be washed off and burnt. Wood-work should be washed with water and soft soap. If chloride of lime be used it should be placed in a large shallow dish, and sulphuric acid, diluted with water, poured upon it. The rest of the procedure is the same as described. It is to be noted that the chlorine gas will remove the colour from coloured stuffs.

Heat is by far the best disinfectant. The best way of disinfecting beds, bedding, and articles of clothing that cannot be washed easily, is to expose them in a hot-air chamber for two hours or more to a heat ranging between 210 and 250° Fahrenheit.

As such an arrangement is only possible in hospitals, &c., and many other methods of disinfection are often not at hand, it should be stated that the sanitary authorities of Glasgow have found that thorough washing and boiling, in the ordinary way, are sufficient to disinfect them completely. In the absence of other methods, then, if all clothes of every description were plunged, immediately on removal from the patient, even before passing from his room, into tubs containing water and ordinary washing soda, and so carried from the patient's room, allowed to steep, and then washed and boiled, the risk of communicating disease by them would be reduced to very little.

Rules to be adopted in every case of infectious disease to prevent infection spreading:—

1. Place the patient in a room by himself, from which carpets, curtains, and hangings of every description, including pictures, &c., have been removed. All furniture, except a wooden table and chair, should also be removed. The room should be well ventilated. This is best done by keeping a fire always burning in the

grate. The floor should be kept clean, and sprinkled with Condy's fluid, or solution of carbolic acid, 1 ounce in 20 of water. The door should be kept closed, and a sheet should hang outside it, and be sprinkled daily with the Condy's fluid or carbolic acid solution.

2. Let none come near the room except the nurse and medical attendant. The nurse should wear some dress that will wash. She should keep her hands clean by washing, as noted above. When she must attend to other household duties, she should take off her dress before leaving the room and put on another kept hanging outside for the purpose. She should mix as little as possible with other members of the household.

3. All cups, plates, and utensils used by the patient should be passed through a solution of chloride of lime (2 ounces to the gallon of water) immediately on being taken from him, and should be afterwards washed in boiling water.

4. All towels, handkerchiefs, clothes, &c., used in the room should be steeped in the weak chloride of lime or carbolic acid solution.

5. All the patient's discharges, spit, vomit, discharges from bowels, &c., should be treated as noted on p. 396. All remains of food and drink should be similarly treated and thrown out.

6. The patient should be kept clean, as directed on p. 395.

7. On recovery, and before mixing with other members of the household, the patient should be bathed and clothed in a completely fresh set of clothing, from the skin outwards, which clothing must not have been kept in the sick room.

8. After the removal of the patient, the room and all articles of clothing left in it should be disinfected, as directed on p. 396.

9. The house should be kept clean and well ventilated during the sickness, the water-closets being specially attended to.

10. Should the patient have died, it is desirable to disinfect the body by wrapping it in sheets wet with carbolic acid solution (1 ounce of acid to 20 of water), or chloride of lime solution (1 ounce to 40 of water); and sawdust soaked in either of these solutions may be placed in the coffin.

If these rules seem troublesome to follow out, it should be remembered that the duty to the healthy is not less than to the sick; and where they are neglected and infection spreads, the moral guilt resting on those who have been neglectful is great.

INFECTIOUS FEVERS ATTENDED BY RASH (*Eruption*).

General characters. Fevers accompanied by eruptions (rashes) on the skin were classed by the old authority, Cullen, as **exanthemata.** This term is derived from two Greek words, *ex*, out, and *antheo*, to blossom, and means, therefore, a blossoming out. The phrase **exanthematous fevers** is largely used in medical works to include all the fevers, attended by rash, which are described under the above heading. They have several characters in common.

1. They are all due to the introduction into the body of some special material whose growth in the body is attended by the progress of the disease. They are all contagious or "catching."

2. The fever does not show itself till some time after the poison has obtained entrance into the body. There is an interval, that is to say, between the time the person becomes infected and the time he actually becomes fevered. This interval is called **the period of incubation.** Incubation means the act of hatching, and the idea is that the eggs, so to speak, of the disease require to be in the body for sometime before the disease is hatched out of them.

3. The hatching being completed, the fever appears, lasts a definite time, and runs a certain course in each case.

4. The disease is accompanied by a rash, of a special kind for each fever, which appears and lasts for a certain time, and goes through a regular series of changes.

5. Each fever ends at a certain time, in some cases suddenly after copious sweating or loose motions of the bowels, in other cases gradually diminishing till it has disappeared. In the former cases it is said to end by **crisis** (Greek *krisis*, a decision or turn); in the latter cases it ends by **lysis**, meaning a loosening (Greek *luo*, I dissolve).

6. The fever attacks the same person once only as a general rule.

Regarding these general characters some additional remarks may be made. The first—the catching nature of the eruptive fevers—is very important to notice. Some are much more catching than others. Most people are aware how difficult it is to prevent scarlet fever and measles from spreading, and, among unvaccinated people, small-pox. Typhoid fever, on the other hand, can be more easily confined if great care can be taken to disinfect the patient's discharges and to prevent them in any way getting near to any water supply. It is also important

to notice that in no other way can such a fever arise than by its seed having been sown. It cannot arise anew. It never can be caused by exposure to cold merely, by errors in diet, or in any such way. It cannot, therefore, arise from the entrance into a house of mere sewage gas, and the contamination of the air so caused. This is a point not quite understood. A house may be badly drained, or the drains may not be perfect, and gas from the sewers may thus pass into the house. This is undoubtedly a great evil, because the inmates of the house, breathing the bad air, are liable to suffer from headaches, sickness, sore throats, and various other states of ill-health. Still worse results may follow, for the persons, weakened in their general health, are thus ready victims for any disease they may come in contact with, and fall a prey to special diseases, which, in vigorous health, they would have had a great chance of resisting. But the gas from the drains, *pure and simple*, cannot produce measles, scarlet fever, diphtheria, typhoid fever, or any other special fever. It is only possible for such a fever to be communicated by drains, if the particular poison that is the cause of the fever, has been cast into the drains, from some house, where that particular fever already exists. The mere fact of a drain of a house being in a bad condition is not, therefore, sufficient evidence of the source of a special fever. Drains are only one of many channels along which contagion may spread.

The period of incubation (hatching) varies for different fevers, as shown in the table on p. 399. This is not to be forgotten in trying to trace the source of the disease. A person may move from one part of the country to another, and, some days after he has entered his new abode, fever may declare itself in his household. He must not, without deliberation, blame the new house. The disease may have been brought with him; and it may be his old place of living that is to blame.

While these fevers always have a definite course, the illness may not end with the natural conclusion of the fever. Some disease of kidneys, lungs, bowels, or other organ may arise in the course of the fever, prolonging the illness or causing death. It is to such causes, complications as they are called, that relapses are due. They are not, as a rule, renewed attacks of the original fever, but interruptions to the recovery owing to the affection of some organ that has specially suffered.

The facts that these special fevers have a regular progress of their own, and will end at a certain time, unless something occurs to disturb the course to recovery, afford important indications for treatment. So far as present medical knowledge extends, to attempt to cut short the fever at any stage is vain. Such a thing would only be attempted or suggested by ignorance. It could only be possible if one knew the real character of the material that caused each fever, and of something that was able to destroy it in the blood of the person ill, without also injuring the patient. Such knowledge is not possessed regarding any of the eruptive fevers (see CONTAGION, p. 384). All, therefore, that one can do for a fever patient is to aid the progress of the disease, to watch the state of the organs specially liable to give way in the particular case, and to avoid the complication if possible, and by proper dieting to maintain the patient's strength for fighting out the disease.

The general treatment of fever appears thus to be easily understood and not difficult to carry out. In fact it comes to be a matter rather of nursing than of medicine giving. To a great many people such treatment is too simple. The doctor walks in daily, carefully looks at his patient, asks a few questions, gives some instructions about food—perhaps orders a dose of simple opening medicine—and goes. Some people regard this as trifling. They are not satisfied if they have not the accustomed "bottle" to administer in frequent spoonfuls. The treatment is not heroic enough unless several mixtures of various kinds and colours accompany the progress of the fever. If the doctor does not "come up" to their expectations in this respect, they busy themselves wondering at it, discuss the matter with their friends, perhaps, and as often as not convince themselves of the necessity of making up for the doctor's omissions by administering, unknown to him, some remedy they think suitable to the case. This, or something like this, is not an uncommon experience. Now everyone in charge of a fever patient ought to remember that the sin to avoid is meddlesomeness. If the patient is kept dry and clean in bed, if small quantities of beef-tea, milk, thin mutton-broth, and similar foods are given frequently, so that within 24 hours sufficient for nourishment has been supplied, if care is taken that water is regularly passed, and the bowels are regularly moved, for which an occasional dose of castor-oil, seidlitz-powder, &c., may be necessary, and if, generally speaking, the patient is carefully and quietly tended, that is the main part of the treatment for a case of fever running an ordinary course.

TABLE OF FEVERS ATTENDED BY RASH.

Name of Fever.	Period of Incubation (Hatching).	Rash appears.	Rash fades.	
Scarlet Fever.	4 to 6 days.	2d day of fever.	5th day of fever.	Scarf-skin begins to peel by 10th day, and continues separating for 4 or 5 weeks after.
Measles.	12 to 14 days.	3d or 4th " "	7th " "	
Small-pox.	12 to 14 "	3d " "	Crusts of pox begin to fall about 14th day.	Rash first pimples, then blebs, then the fluid of the blebs becomes matter, and by 14th day has dried into crusts.
Chicken-pox.	13 days.	1st " "	Crusts begin to fall about 7th day.	Rash of pimples becomes blebs; scabs formed by 6th day.
Typhoid Fever (Enteric Fever).	Uncertain. In some cases 21 days.	7th or 8th " "	Comes out in crops, till end of 3d week.	Fever gradually passes away after 21 days, but is often prolonged by complications, &c.
Typhus Fever.	5 to 12 days.	5th to 7th " "	Beginning of 3d week.	Fever lasts 14 days. Crisis in 3d week.
Dandy-fever (Dengue).	5 to 6 days.	3d " "	5th or 6th day of fever.	Second attack of fever and rash follows first after two or three days, lasts shorter time.

Scarlet Fever (Plate VI.) is extremely infectious, very common among children, and often more dangerous because of its consequences than on account of the actual fever.

The **symptoms** of an ordinary case are that the person complains of shivering, weariness, headache and sickness, and *sore throat*. In children a convulsive fit, instead of shivering, not seldom begins the illness. There is great heat and dryness of the skin, and frequently the dulness and drowsiness of the patient are quite marked. Some amount of delirium is frequently present. There is thirst but no desire for food. The pulse is very fast. The appearance of the tongue is peculiar. It is thinly coated with a white fur, but is red at the edges and tip, and numerous minute red points are seen standing out, giving an appearance indicated by the phrase—"strawberry tongue," or "raspberry tongue." This is specially seen on the fourth or fifth day of the fever. The sides of the jaws are slightly swollen, stiff, and sore. On the *second* day of the fever the rash comes out. It comes out in fine red points so numerous and grouped so closely that the skin appears red all over. Appearing first on the face, sides of the neck, and breast, it is soon spread all over the body. It is most intense by the fourth day, and begins to fade on the fifth, disappearing before the end of the seventh. The intense redness of the skin may be shown by contrast, by drawing the point of the finger firmly over it. A white mark is produced, to which the redness quickly returns. The soreness of the throat may be felt a day or two before the fever—it increases up to the time of the rash appearing—the tonsils (p. 136) being very red and swollen, and in ordinary cases it diminishes when the eruption reaches its height. With the fading of the rash the pulse becomes less quick, the fever lessens, and all the symptoms improve, and in the course of a few days the fever and its attendant quick pulse, &c., has departed.

With the disappearance of the rash another peculiarity of the disease presents itself, namely, desquamation or shedding of the skin. The scarf-skin begins to separate in fine or large scales, or in large flakes. It begins on the neck and chest, spreads to the other parts of the body, and to the hands and feet last. Sometimes the scarf-skin of the hand will separate all together as a glove, or that of the foot like a slipper. It usually peels off in large pieces. This shedding of the skin lasts a considerable time. As a rule it is complete by the *sixth* week from the beginning of the fever, but it may end much sooner.

Now the chief elements in these symptoms are the sore throat, the scarlet rash, and the shedding of the skin.

While the above statement gives the symptoms and course of an ordinary fully-developed attack of scarlet fever, there are some varieties.

The attack may be mild, exhibiting the main symptoms but in a very slight degree, and often after the first day or two the patient is so little affected that he or she seriously objects to the confinement. It is to this form the term **scarlatina** is applied. It means merely a mild attack of scarlet fever. Practically, however, *the mild attacks are often found to be more serious than the severer form* just described. *Scarlatina is capable, by infection, of communicating the worst type of the disease, causing rapid death.* Moreover, the evil consequences, so common in the disease, as readily attend the mild as the

severe form. In a mild case it is often difficult to impress the patient, or, in the case of a child, its parents or nurse, with a due sense of the risks. Less care is exercised, there is improper exposure, and dropsy or other symptoms of kidney disease speedily appear. *The mildest case of scarlatina ought to be treated with the same watchful care as the most severe.* There are even milder cases of scarlet fever than those noted. A child is feverish and unwell for a day or two, and apparently becomes quite well, though unusually pale and not strong. No rash has appeared, or at least has been noticed. But, in a week or ten days after, the glands at the side of the jaws swell, the ears become sore, perhaps the skin peels, or other symptoms lead to the conclusion that the child has suffered from scarlet fever.

Again there is a malignant form of the disease, in which there are great brain disturbance, convulsions, and low muttering delirium. The tongue is dry, the throat dark-red, ulcerated, and sloughing. The rash comes out late, and speedily disappears. Death may occur before the rash has time to appear.

Scarlet fever occurring at or immediately after childbirth assumes very fatal characters. It is a form of puerperal fever.

The results of scarlet fever are many. Abscesses may form in the throat or in the glands at the sides of the jaw; suppuration may occur in the nostrils and in the eustachian tube (p. 356) leading to the ear. Disease of the ear, accompanied by discharge and ending in deafness, is common. Various affections of the membrane surrounding the heart (pericardium, p. 238) and lung (pleura, p. 266) may arise. Rheumatism is apt to follow. The chief result is inflammation of the kidneys (p. 295), attended by dropsy and albumen in the urine. Inflammations of the eyes are not infrequent.

The infection of scarlet fever is undoubtedly at its worst during the shedding of the skin, but not at this period only. It is very probable that the sore throat is also infectious, and that therefore the disease is "catching" from its commencement to its termination.

Treatment.—*Disinfection should be practised from the beginning in the manner* advised on p. 396. At the beginning of the disease nothing is more valuable than a warm bath, which the patient should remain in for from 20 minutes to half an hour. Before the bath a double-strong seidlitz-powder should be given, to children one or two tea-spoonfuls of citrate of magnesia or a dose of castor-oil. Failing the bath, the person should be wrapped, naked, in a blanket wrung out of warm water and rolled in warm dry blankets. After an hour or more the wet things may be removed and dry warm clothes put in their place. The patient should be kept strictly to bed in a well-ventilated room, in which a fire is kept burning. If the fever runs high the wet pack *with cold water* may be repeatedly used if soothing to the patient. For food, milk, beef-tea, strained mutton-broth, switched eggs, and such articles are allowed. To encourage the action of the skin and kidneys the ammonia and ether mixture (PRESCRIPTIONS — FEVER MIXTURES) is valuable. Inhaling the steam of boiling water or sipping warm milk relieves the throat. A warm application over the throat may also be used if the pain is severe. Sometimes nothing is so soothing as allowing a piece of ice to melt in the mouth, and with children giving a tea-spoonful of iced milk or water now and again. If the fever runs high, quinine is the best remedy, of which one grain for every two years of age is given, and repeated every six hours as required. For adults the dose is 5 or 10 grains. When the fever has departed, strengthening food is necessary, and iron and quinine tonics. Daily during the progress of the case, including the period of fever, sponging the body with lukewarm water containing some vinegar is very relieving. The whole body need not be done at once, but by two bathings each day. When the skin begins to separate the body should be rubbed all over with carbolic or camphorated oil. This prevents the scales of the skin being scattered through the air, and diminishes the risk of infection. This should be repeated daily till all the skin has separated. The patient should not be permitted to leave his room or mix with others till all the skin has been shed, and then only after proper disinfection, as recommended on pp. 395, 396.

Grave cases, and cases of kidney disease, &c., must be in the care of a physician. Discharge from the ear should, from the very first appearance of it, be treated as advised for that affection on p. 398.

Measles (*Morbilli—Rubeola*, Plate VI.) is an infectious disease occurring most commonly among children, not because grown-up people are less liable to be attacked, but because most people have it in childhood, and one attack protects, as a rule, against another. This is not a rule, however, that has no exceptions; for many cases have been observed of persons attacked for the second time, though that is not common.

The **cause** of the disease is, without exception, contagion; that is to say, a special kind of poisonous material is thrown off from the body of a person suffering from measles, which, gaining entrance to the body of a healthy person, gives rise to a new case of the disease. It can never arise anew. The measles germs or seeds must be sown before a crop of measles can arise. Measles thus spreads, like scarlet fever, from person to person, one case being capable of infecting any number of others. It clings to clothing, and to other surfaces. Many people forget this. They visit those sick of the disease without fear for themselves, because they have had it before, forgetting the risk they run of carrying away with them seeds of the disease, to infect others with whom they come in contact. Parents too often forget it when they send their children out to play, or back to school, a sufficient time after their recovery, but without previously disinfecting their clothing. It is for such reasons that, when one of a family is sick of measles, the others, if they are living in the same house, should be kept at home, not only from school but from playing with neighbours' children, lest they spread the fever. It would appear that one who has suffered from measles is scarcely free of the power of imparting the disease till about the end of a month. Of course the infection may cling to rooms and clothing, that have not been disinfected, for a much longer time. Measles is infectious almost from the beginning, at least it is infectious even before the rash has appeared, and therefore, even before the real nature of the affection is quite certain. A patient may, thus, have already imparted the disease to others before it could be known that he was himself suffering from it. This is different from scarlet fever, in which the chief period of infection is while the scarf-skin is separating—the period of desquamation, as it is called.

Symptoms do not show themselves till from twelve to fourteen days after infection. The attack begins with signs resembling those of cold-in-the-head (catarrh, p. 154). There are chills or shivering fits, in children sometimes convulsions, followed by evident fever. The appetite is lost, the tongue white, and there may be vomiting. Cough is present, generally of a harsh barking character. There is sneezing, the eyes are red and watery and sensitive to light, and the head aches. These symptoms increase up to the fourth day, when the rash begins to appear, at first on the forehead and temples, at the edge of the hair, and then on the cheeks, chin, and neck. It then extends downwards over chest, arms, belly, and legs. On the fourth day the fever seems to be at its height. It may reach 104° Fahrenheit (see p.10), accompanied by rapid pulse and sometimes delirium. The rash consists of well-marked, red, roundish spots, *raised above the skin*. Appearing first here and there, they quickly form groups, which run together into irregular patches. When they are numerous the skin is swollen. The face is thus very red, and irregularly swollen and rough, when the rash is well out. The spots being raised above the surface, the skin feels very rough, and so measles is easily distinguished from scarlet fever, in which there are no raised spots but only a general redness. If the rash is well 'out' by the fourth day, then on the fifth the fever usually is much diminished, the cough is softer, and the pulse less rapid. Within two days of its appearance the rash begins to fade, disappearing from the different parts in the order in which it came, but leaving a mottling of the skin, of a dusky colour, which does not completely fade for ten days or longer. Very fine scales separate from the skin, of the face and neck in particular, on the disappearance of the rash. In ordinary cases, without complications, the fever has almost if not quite passed away by the seventh day, leaving the patient weak.

It is very common for the cough to be the first thing to attract special attention. A child, who has been restless and irritable during the day, rouses its parents in the night by a hoarse barking cough, which immediately suggests croup to their minds. It has not the metallic, brassy ring of croup, however, for which it may be mistaken till, in one or two days, out comes the measles rash, showing the true nature of the illness.

Measles is not the very simple disease that many people seem to imagine. Bronchitis is a very common complication, maintaining the high fever beyond the sixth or seventh day, delaying recovery, or causing death. In young children the attack of the disease with the accompanying affection of the chest may be so severe as to cause death before the rash has time to appear. In hot weather an attack of diarrhœa is serious, and in hot climates dysentery is not an infrequent bad attendant of the attack. In cases of children with not robust constitutions, measles is apt to leave very weakened conditions of general health. Serious inflammation and ulceration of the eyes, discharges from the ears, and swellings of glands often

follow an attack of measles in unhealthy children, and are very difficult of cure.

Persons may suffer from measles and mumps or whooping-cough at the same time.

Treatment.—From the very beginning of the disease, before the suspicion of its nature has time to be confirmed or otherwise, the patient should be separated from others, and steps should be taken for disinfection, as described on p. 395. The person must be kept quiet in bed in a room kept at a regular degree of warmth, but yet with plenty of pure air. Draughts and chills should be carefully avoided. Bread and milk, beef-tea, mutton broth, and such mild food ought to form the diet. If the fever is high and the patient restless, a warm bath is of great service, or sponging with lukewarm water. The cough may be relieved by gargling the throat with warm milk. Sometimes sucking a small piece of ice is very grateful, but much improvement need not be expected till the fever begins to diminish. To aid in promoting the action of the skin and kidneys the following mixture is valuable:—

Solution of the Acetate of Ammonia, ...	1½	ounce.
Spirit of Nitrous Ether, ...	½	,,
Ipecacuanha Wine, ...	¼	,,
Mucilage (Solution of Gum Arabic), ...	1	,,
Water, ...	1	,,

Give from a half to one tea-spoonful (according to age) every two or three hours.

This is specially useful at the height of the fever. If convulsions occur, a warm bath should be employed.

As recovery takes place the food should gradually return to the full ordinary diet. After the disappearance of the fever, if exhaustion is great, small quantities of port wine are necessary, but not otherwise. A dose of mild opening medicine is occasionally necessary, but is to be carefully given, from the risk of looseness of the bowels.

Affections of the ears and eyes are to be treated as recommended in Section XII. B.

German Measles (*False Measles, Rötheln, Rubella, Epidemic Roseola*) is a disease apt to be mistaken for measles, and even scarlet fever. It differs from measles in there being little sneezing, little cough, and nothing of the red watery eyes, all of which are characteristic signs of measles. It is a different disease from measles, for, while one attack of measles protects, as a rule, from a second, an attack of false measles gives no protection from true measles, though it protects against a second attack of its own kind. It never develops into true measles, though a child may have a real attack of measles shortly after an attack of German measles. It is not so contagious as true measles. The affection does not show itself till from one to two weeks after infection.

Symptoms.—The disease is marked by an eruption, appearing first on the face and quickly spreading over forearm and hands, legs and feet, and rapidly covering the whole body. The spots are *raised above the skin*, of a dusky red, irregular in shape, and they soon run together. This eruption is accompanied by little fever. The patient may complain of a feeling of fulness of the head, of giddiness, and perhaps of some headache, in short of being a little "out of sorts," and frequently does not complain at all, the rash being attended by apparently no disturbance. Moreover, before the eruption there is often little complaint. In true measles, as noted on p. 401, there is considerable fever, with severe cough, sneezing, and other signs of cold-in-the-head, and the fever usually reaches its height when the rash appears on *the fourth day*. Now, in false measles, if there is any disturbance before the fever it is slight, and usually the rash appears *within one day, or at the most two days*, of the person feeling unwell. It does, however, sometimes happen that there is considerable fever, loss of appetite, &c., before and during the rash, and in young children the disease occasionally sets in with vomiting, diarrhœa, and convulsions. On the second day the rash is fully out, and immediately begins to disappear, fading by the third or fourth day. It is accompanied by itching, but on fading it leaves no mottling of the skin as measles, though the separation of fine scales of the scarf-skin may follow it.

Treatment.—Rest in bed for three or four days, and such mild diet as recommended for measles are sufficient treatment. The infectious character of the disease must not be forgotten, and as the infection probably lasts for some weeks, care should be taken that the disease is not spread.

Small-pox is a contagious and infectious disease. Its chief feature is the appearance of a rash on the skin, consisting first of pimples, which enlarge and become little sacs filled with clear fluid, afterwards changing into matter. Scabs form when the matter dries up, and on their fall, they leave marks or not according to the severity of the attack. There are different degrees of severity of an attack of small-pox, in-

dicated by the eruption. In the less serious form the different pocks are separate from one another, and the small-pox is said to be *distinct* or *discrete*, in a more violent form the pocks run together, and the disease is said to be *confluent*. The former kind is often fatal, the latter nearly always so. The disease, like other contagious fevers, has a period of incubation, there is, that is to say, an interval between the time when the disease is caught and the time when it begins to show itself. That period is from eight to eleven days. In all cases several stages can be recognized in the progress of the fever. These stages are—that of *invasion*, the period of the beginning of the attack, that of *eruption*, the period when the rash appears, that of *suppuration*, the period during which the contents of the pocks become matter, and that of *drying-up* or *desiccation*, when crusts form. The time of these stages may be given. As a rule the fever begins *eight or twelve days after* the disease is "caught;" *on the third day* of the fever the eruption appears; *about the eighth day* suppuration begins, and lasts till the eleventh, after which the drying-up process goes on; the scabs tend to separate *about the fifteenth, eighteenth, or twentieth day*. These are the times for the appearance, suppuration, and drying-up of the eruption *on the face*. On other parts of the body the various stages are a little later in occurrence.

Symptoms of Distinct Small-pox.—The chief symptoms at the beginning of this form are fever and constant sweating, vomiting and costiveness of the bowels, and severe pain in the small of the back.

The attack is usually sudden. The patient is seized with shivering fits (rigors) followed by great heat of the skin. The sweating is marked for several days in grown-up persons, not in children. In children also diarrhœa (looseness of the bowels) is usual and not costiveness, but in adults diarrhœa is rather the indication of a very severe attack. Convulsions are also common in children. The pain in the back is usually severe, and may be attended by numbness or paralysis of the legs and difficulty in making water. Instead of the severe pain in the small of the back, there may be dull pains throughout the body like those of rheumatism. During this time the fever runs high.

With the beginning of the *second stage*—the appearance of the eruption—the fever falls and the other symptoms disappear, so that the patient may seem to be almost well. This continues till about the eighth day, when the fever returns with the suppuration of the pocks. The eruption, as it appears on the third day, consists of small red hard points, slightly raised above the skin. They grow larger, and in the course of a day form hard prominent pimples. In the course of two more days they have become converted into vesicles, that is, small sacs or blebs containing a milk-like fluid. They go on increasing in size. On the eighth day the fluid they contain has become yellowish, and consists of matter or pus. Hence the eruption consists now of pustules, or small abscesses. On this day, also, the skin around each pock or pustule is distinctly red. There is, indeed, a ring of inflammation round each. Accompanying the inflammation there is swelling in the skin and parts beneath it. The pustules are painful and the fever returns.

The return of the fever marks the arrival of the *third stage*, that of suppuration. The pustules still increase in size, and the yellowness of their contents becomes more visible. This stage is marked also by swelling, already noted, of the parts on which the eruption is seated, which increases up to the *ninth day* of the disease, and then diminishes, disappearing about the eleventh day. It is greatest where the skin is loose, and thus is often very great on the eyelids, causing complete closure of the eyes. It is marked on the hands and feet. The fever of the period of suppuration may not be so high as the early fever. It is accompanied by shiverings, quick pulse, loss of appetite, furred tongue, and delirium. It lasts for three days, and then if the case progresses favourably, rapidly disappears, not to return, and the other symptoms with it. The pustules thereafter pass through the process of drying-up, to be noticed immediately.

The eruption does not appear all over the body at once. It begins on the face and neck, spreads to the upper part of the chest, arms, and hands, to the rest of the body later, and to the legs last. In the course of two days it will have spread over the body. But those on the face having appeared first, will always be in advance of the others, and thus those on the face may be dried up while those on the legs are only fully ripe. The eruption is also present on the lining membrane of the throat and mouth, and causes pain in the throat, felt from the commencement of the rash. It is also sometimes present on the lining membrane of the eyelids (the conjunctiva, p. 339), and may lead to serious injury of the eyes. The pocks on the body have often a depression in the centre, not seen in those on the face. Pocks showing this are said to be umbilicated.

The *final stage* of small-pox is that in which the pustules dry and form scabs. The scabs begin to fall from the face between the fifteenth and twentieth days, and a little later from the body. A red prominence is left, after the fall of the scab, on which scales form, and from which they fall for, it may be, several weeks. Finally after some months the redness disappears, and a white scar is left, below the level of the rest of the skin. If the pocks have not been large, the marks may be very slight.

Such is the history of **distinct small-pox.** It is one of the least fatal forms of the disease, except in unvaccinated children below one year of age. Nevertheless it may prove fatal even in grown-up persons. When death occurs from distinct small-pox, it happens about the eighth or ninth day. According to the French physician, Trousseau, a fatal issue is to be feared when the eruption does not come well out by the fifth, sixth, or seventh day, when the pustules are irregularly formed, when the sweating ceases suddenly and cannot be recalled, and when delirium occurs with dry cold skin and a weak, sharp, irregular pulse. Profound unconsciousness and twitchings of the tendons are signs of approaching death.

Symptoms of Confluent Small-pox.—The confluent form of the disease, in which the pocks run together, is a very fatal form. The symptoms of its commencement are similar to, but more severe than, those already described. The pains are more intense, fever more decided, and vomiting continuous. The eruption comes out earlier than in the ordinary case, appearing on the second day instead of the third, though in very bad cases the rash may be delayed. The fever is not only very high, but it does not fall for any time between the period of the rash appearing and the period of the pocks ripening, as it does in distinct small-pox. It is almost continuous till the pustules have become yellow with matter. The eruption, which, as already stated, appears early, and may at first be mistaken for measles, because of the general redness of the face, consists of small pimples extremely close set. As they grow in size great swelling of the face is produced, and when they grow into blebs, they so run together that large patches of raised skin are produced like that caused by a blister. The swelling of the face is accompanied by swollen eyelids, swollen jaws and ears, and there are constant flow of water (saliva) from the mouth, and harsh cough. The ball of the eye may be fiercely attacked and vision destroyed. The swelling of the face and the flow from the mouth should begin to diminish by the eleventh day. At the same time there occurs great swelling of the hands and feet, due to the pustules, and the swelling is accompanied by pain. When the pustules have become ripe, full of matter, which occurs between the eleventh and thirteenth day, they give out a most disgusting stench, and the patient's skin is in a most serious condition, with the leaking pustules, ulcers formed from them, and often boils and abscesses, due to some extent to the irritation of the decomposing matter of the pocks. (Plate VII.).

Delirium, in confluent small-pox, is apt to continue from the fifth day of the disease till the thirteenth or fourteenth day, when it should cease. But the fever has not such a defined period, for it may be maintained beyond the third week by the formation of boils and abscesses in the skin, and also in deeper parts. At this late period attacks of shivering, with high fever, indicate the formation of deep boils.

In confluent cases death is very common, and usually occurs between the eleventh and fourteenth days. Excessive delirium, or deep unconsciousness, great prostration, much difficulty of breathing, and anxiety, these are all bad signs. Death sometimes arises from suffocation by swelling and the formation of membranes in the throat. Inflammation of the lungs may hasten a fatal termination. But even should the patient survive this period, prostration and death are too apt to be the result of the prolonged formation of boils, &c., in the skin and deeper parts.

Black Small-pox is the most fatal form, and is so called, because, while the ordinary rash is scanty there is an eruption of dark blue, violet, or black spots. These are due to bleeding that has taken place into the skin, and in some cases blood is lost from the nose, mouth, and other parts. Such cases are accompanied by delirium and high fever and rapidly end in death.

Treatment.—As in other fevers with rash, no attempt need be made to arrest or cure an attack of small-pox. It will run its own course. All that remains for friends or doctor to do is to "stand by," and do all that is possible for the patient's comfort and for the maintenance of his strength. The patient should be placed in a large well-ventilated room. The patient must not be heavily covered. His body and his bed should be kept as clean as possible, sponging with lukewarm water may be adopted, and the bed-sheets should frequently be changed. The skin may be anointed, after sponging, with

olive-oil or vaseline. Mutton broth, milk, beef-tea, &c., should be given in small quantities frequently. Lemonade, or gingerade, or acid drinks made with dilute sulphuric acid, are grateful. If delirium and excitement are great, lukewarm baths are of use. The attendants should have been vaccinated. A patient who recovers must not be allowed to mix with other persons till all crusts and scales have disappeared, and till daily baths for a week have been taken. The utmost care must be taken to prevent the spread of the disease, as advised on p. 395. During a small-pox epidemic all unvaccinated persons should be vaccinated, and among those who have been vaccinated, but as long before as seven years, re-vaccination should be practised.

Small-pox as altered by Vaccination (*Modified Small-pox—Horn-pox*).—While vaccination, if properly performed, as a general rule protects from small-pox, yet a vaccinated person may take the disease; but it does not run the ordinary course, and the risk attending it is slight. In the same way a person who has had small-pox is protected, as a general rule, from a second attack. Yet cases do occur where the disease attacks for the second time, and in this case also it does not run its full course. In both cases the disease is altered. It is, nevertheless, the same disease, for if a person suffering from the altered form communicates the disease to an unvaccinated person, in that person it will appear in its ordinary unaltered form. A vaccinated person suffering from a mild attack of small-pox may thus communicate the disease in its most aggravated form to an unvaccinated person. (Eruption is shown on Plate VII.)

The **symptoms** of altered small-pox are up to a certain point similar to those described under distinct small-pox. The symptoms at the beginning are the same—shivering, fever, pains in the back, vomiting—but they are milder. The eruption comes out about the same time—the third or fourth day—but the pimples are few in number. They suddenly cease to progress in the usual way, and soon disappear. Or the eruption comes out as usual, progresses to the stage of forming blebs, and then dries up without any fever of suppuration. Even when the pocks reach a more advanced stage, swelling of the face, of the hands and feet, and other symptoms of the bad forms of small-pox are scarcely ever seen in small-pox altered by vaccination. In short the disease never gets a proper hold of the person. It may flourish for a few days, but speedily looses its hold and convalescence begins. Just as some seeds sown in particular kinds of soil may never produce good fruit, because the soil is deficient in the particular kind of nourishment they need, so that they spring up and progress to a certain stage only to wither away, so, in a person who has had small-pox previously or has been vaccinated, there seems to be a want of the particular elements in the blood and body on which the small-pox poison flourishes. They either are, on that account, unable to take a second attack, or, if they take it, the disease advances only a little way and then abruptly terminates.

Inoculated Small-pox.—Long before vaccination was known it had been observed that persons who were inoculated with small-pox, into whose skin, that is to say, the small-pox poison was deliberately inserted, suffered usually from a milder form of the disease than those who caught the infection in the ordinary way, while at the same time they were protected from another attack. It appears that the habit of inoculating small-pox was practised from time immemorial in Persia and China, just because small-pox was so common that few could escape it, and because the attack was less likely to be fatal when deliberately communicated in this way. An English lady, Lady Mary Wortley Montague, observed the practice while residing in Constantinople in 1717, and had her son of six years of age inoculated with success. Returning to England she announced the practice in 1721, and had it performed with good result upon her daughter. As a result the practice spread, but met with much opposition. But after a time it was accepted, and generally performed till vaccination was introduced.

On the second day after matter from a small-pox pustule has been introduced under the skin of a person, a pimple appears at the spot. By the fourth day it has become a bleb, and by the seventh or eighth the milky fluid in the bleb has become matter, that is, the bleb has become a pustule. It is surrounded by a red inflamed ring, which increases up to the tenth day, and on which a number of smaller pustules appear, round the large one, which also increases in size. It is not till this time that any signs of general disturbance appear. But now shiverings occur, fever arises, headache and pains in the loins are felt, and there is vomiting—the usual signs of the beginning of an attack of small-pox. On the eleventh, twelfth, or thirteenth day after the

inoculation the ordinary small-pox rash appears, which follows the course described under **distinct small-pox.**

Small-pox so produced is infectious, and an inoculated person might, therefore, originate an epidemic. Moreover, though usually mild, it was sometimes disfiguring and fatal. One can, then, understand how, at one time, the disease was feared and dreaded, when persons would run the risk of being inoculated rather than take the chance of escaping infection in the ordinary way. This is one of many facts of which the agitators, who denounce vaccination, are surely ignorant.

Vaccination (from Latin, *vacca*, a cow. *Cow-pox*). (Plate VI.) In spite of inoculation, practised as described in the preceding paragraphs, the mortality from small-pox seemed to be on the increase in Britain, when, in 1798, Edward Jenner, a surgeon practising in Gloucestershire, published an inquiry into the causes and effects of cow-pow.

Cow-pox is a disease of oxen, manifested by the appearance, usually on the teats and udders of cows, of pocks, which almost exactly resemble those of small-pox. There is also a disease of the horse, called **horse-pox,** supposed to be the same disease to which the term **grease** is applied, which is believed to be the same disease as cow-pox. Cow-pox is a contagious disease, and is liable to break out as an epidemic among cattle. Now, anyone who milks a cow, suffering from this disease, is liable to get on the hands some of the matter from the pocks, and if by a scratch or other pathway the matter can pass into the system of the person, that person is likely to contract the disease, which will show itself by the appearance of pocks at the infected parts, but by no other symptoms of any consequence. It had been for long a tradition among dairy-folks that anyone who had thus contracted cow-pox was safe from the risk of an attack of small-pox. This notion Edward Jenner had become aware of while still an apprentice to a surgeon, and it took firm hold of his mind. For years he did not cease to think of it, to inquire concerning its truth, to make observations and experiments as well. For thirty years he worked quietly at the subject, and then he published his work on cow-pox, which completely established the truth of the old and vague idea, and raised it at once to the rank of a scientific fact. He gave details of persons who had accidentally contracted cow-pox, and who had remained proof against the infection of small-pox. He showed that persons who had thus been accidentally vaccinated were safe from small-pox even when small-pox matter was deliberately introduced into their bodies. He did more. He took matter from the pocks of a cow and introduced it into the skin of a child. In time this child showed the pocks of vaccination, now so familiar to every one. With matter from this child he vaccinated a second, and with matter from the second he vaccinated a third, and so on through five generations. Then into the body of the child vaccinated last *he introduced small-pox poison and found it proof against the disease.* This was convincing evidence that the matter of the cow-pox could still protect from small-pox even after it had passed through the systems of many persons in succession. It was not, therefore, necessary to go back to the cow for matter. After the publication of Jenner's work his statements were subjected to tests of the utmost severity, and were found to be perfectly unassailable. Thus at the London Small-pox Hospital, in the two years following that of Jenner's publication, 7500 persons were vaccinated, and about one half were afterwards inoculated with small-pox poison without the slightest effect.

Course of the Vaccination Pocks.—When a person has been properly vaccinated, nothing appears where the matter has been inserted till the second or third day, when a small red pimple shows itself. This grows larger and becomes, by the fifth or sixth day, a rounded greyish bleb filled with clear fluid, and usually not raised in the centre. It goes on becoming larger till the eighth day. After this the clear contents begin to become yellowish, the skin round the pock becomes red, inflamed, and thickened, and by the tenth day the skin for some distance round the pock is deeply red and hard, and the contents of the pock have become yellow matter. The pock now begins to dry up, and the inflammation and hardening round about to lessen, till by the fourteenth or fifteenth day the pock has changed to a dry dark scab, which falls about the twentieth day or a few days later, leaving a scar in the skin presenting numerous little pits, the surrounding inflammation having disappeared. If the vaccination has been successful the scar remains for life, and is easily recognized. A scar not well marked means imperfect vaccination; and, of course, the degree of safety from small-pox varies with the degree of effect which the vaccination matter has produced in the body of the person. During the progress of the pocks the person exhibits

signs of being generally affected, but not, as a rule, before the eighth day. There is some degree of feverishness, restlessness, irritability, and disturbance of digestion, which soon pass off, but still indicate that the vaccination has produced more effect than simply a pustule at the place where the matter was inserted. If the pocks do not pass through the stages described, if, for example, a scab is formed on the fifth or sixth day which soon falls, the vaccination is not perfect and the protection is not complete.

Now the same pocks are produced whether the matter has been taken direct from the cow or from a person previously vaccinated.

The matter intended for vaccination should be taken from the cow or from the human being *on the eighth day*, while it is still clear and transparent.

Mode of Vaccination.—One of the most valuable parts of Jenner's work was the proof that the matter of the cow-pox could be passed through human beings for many generations without its value being lessened. From each fully grown pock sufficient matter can be obtained to vaccinate about a dozen persons. When the pock is opened by the fine point of a clean lancet, the clear fluid runs out, and this fluid may be placed on the skin of an unvaccinated person from the lancet point, and caused to enter the blood by the point being passed into the skin sufficiently deeply to reach the true skin. A simple method consists in making a series of scratches across one another (as in Fig. 181), with the clean lancet point, on the part of the skin where the matter is placed. The scratches should be just deep enough to show blood. If they are too deep, the flow of blood may wash the matter away. The upper part of the arm is usually chosen. The matter may be kept for any length of time in properly sealed tubes. Extremely fine hair-like tubes are used. When the end of the tube is placed in a drop of the fluid, the matter passes up by attraction, and when the tube is thus three-parts filled, the ends are sealed in a flame. Or the matter may be placed on small slips of glass or on clean quill points and allowed to dry. When the matter is required for use, the ends of the tube are broken off and it is blown out on to the skin, or the plates or quills are moistened with a small drop of pure water and rubbed on the skin where the scratches are made. Thus from one good pock sufficient matter may be preserved to vaccinate half-a-dozen or a dozen persons.

Fig. 181.

Objections to Vaccination.—It might have been supposed that when Jenner had conclusively shown the value of his practice, and when cases by the thousand and tens of thousand confirmed his views, and proved that by means of vaccination a hateful disease, which killed thousands annually and mutilated for life many thousands more, could be rendered practically harmless, it might have been supposed that the acceptance of the practice would have been universal. But it was not so. Objectors rose on every side, and the more successful the method was shown to be the more vigorous became the opposition. One set of objections was sentimental. It was maintained that with the cow-pox some of the disposition of the ox would be imparted. It was declared that the moral character of children became perverted, that they exhibited the effects of a "bestial humour," that as vaccination was carried on the human race would degenerate, that innumerable evils would arise, that innumerable new and unheard-of diseases would appear, that brutal tendencies would appear in vaccinated children, and that even brutal features would show themselves, in the appearance of horns, hair, perhaps tails, in the expression of the voice, which would become bellowing, in the character, which would become bullying. Pamphlets and doggerel rhymes of the wildest description were published to throw discredit on the practice. The following verses from one of these sufficiently show the nature of this opposition:—

O Jenner! thy book nightly phantasies rousing,
Full oft makes me quake for my heart's dearest treasure;
For fancy, in dreams, oft presents them all browsing
On commons, just like little Nebuchadnezzar.

There, nibbling at thistle, stand John, Jem, and Mary,
On their foreheads, O horrible! crumpled horns bud;
There Tom with his tail, and William all hairy,
Reclined in a corner are chewing the cud.

Another kind of objection was of the pious sort. Small-pox was a "merciful provision on the part of Providence to lessen the burthen of a poor man's family;" it was impious to attempt to set aside a divine dispensation; &c., &c.

There were other and more serious objections. It was urged, and proofs were offered in support of the statement, that vaccination did not give the protection asserted, that many vaccinated persons were seized with small-pox, that vaccination so affected the system as to lay it open to such diseases as consumption, scrofula, &c., and that, with the vaccine matter, the poison of such diseases as syphilis might be and was introduced. The result of these more scientific

objections was to rouse the supporters of vaccination to the fullest and most far-reaching inquiries. Medical colleges and medical men were appealed to in every civilized nation, and as a consequence a body of evidence in favour of vaccination was produced, which to this day stands unassailed and unassailable, fitted to convince every rational mind that vaccination, *if properly and universally employed*, affords a method of completely stamping out small-pox from the face of the earth. Anyone who chooses to examine the question for himself will find the facts in "Papers Relating to the History and Practice of Vaccination," presented to the British House of Commons, and published in 1857. Some of the most striking facts may be given. It is estimated that in 100 years before the introduction of vaccination, 45 millions of persons died in Europe of small-pox. In Greenland in 1734 two-thirds of the population were swept away by an epidemic. In Iceland in 1707 it destroyed 18,000 out of a population of about 50,000. In North America one tribe of Indians, numbering 1500 persons, all perished by its ravages excepting only thirty. It is estimated that in the Russian empire alone it had *annually* two millions of victims. After the introduction of vaccination the death-rate from small-pox fell at once, and diminished just in proportion to the thoroughness and extent of the practice. In Sweden, before its introduction, small-pox had annually 2050 victims, after its introduction only 158; in Berlin for 24 years before its introduction the deaths from small-pox were 3422 annually, for 40 years after its introduction the annual death-rate fell to 176; in London the annual deaths from small-pox before vaccination were 3000 to 5000, after its introduction they were under 340. It is to be remembered that these results were obtained when vaccination was not nearly universal, and that the deaths were chiefly among non-vaccinated persons.

It appears, however, quite true that the protection from vaccination is not absolute. That is to say, there have been cases where persons properly vaccinated have yet contracted small-pox, but *in every case the disease was so mild as to cause little risk of death.* Such cases are, however, rare. It was abundantly proved that the very large proportion of cases brought forward of persons who had contracted small-pox after vaccination, were really cases in which the vaccination had been improperly performed. It was shown that matter, in no sense true vaccine matter, might be used which would produce irritation at the point of insertion and set up inflammatory changes, which ignorant persons might suppose to be the vaccine pocks, but were not so. Such false vaccination could not give protection. While this was proved, it is admitted that in a few cases, indeed a very few cases, proper vaccination may not completely protect from small-pox, though it renders the disease extremely mild. But then there are undoubted cases on record where one attack of small-pox itself does not confer complete protection from a second. Indeed it would appear that the protective power of efficient vaccination is of the same extent as the protective power of a previous attack of small-pox.

The explanation of the protection accorded by small-pox is one that was surmised by Jenner himself. Numerous positive experiments go to show that the pocks of the cow and the small-pox of man, as well as (apparently) the pocks of the horse, are due to one and the same poison operating with different degrees of violence on different animals. Thus Mr. Ceely, a surgeon of Aylesbury, began a series of experiments in 1839, which went to prove that small-pox poison introduced into the body of a cow produced cow-pox. Thus, in one case, he introduced small-pox poison into a stirk. At the place of puncture the cow-pox appeared by the sixth day. From one pock he took matter with which he vaccinated several children, and in the children it produced the appearance of ordinary vaccination pocks. He passed this matter through several generations in children, and obtained a supply of matter which was used in the Small-pox Hospital and Cow-pox Institution of Dublin, and gave all the results of ordinary vaccination. Thus small-pox of the human being became cow-pox in the cow, and the matter of the cow-pox, when transferred to the human being, became the vaccination-pox. It thus appears that vaccination protects against small-pox because it is, as regards the poison producing it, the same disease, but deprived of its violence and extremely poisonous character by previous passage through the cow. Therein lies the reason why vaccination cannot protect more absolutely against small-pox than small-pox itself.

As tending to show how the objection that vaccination does not give complete protection against small-pox is rather an argument against imperfect vaccination, one or two facts may be given in the form of a table. The table is based on the observation of 5000 cases of small-pox received in the Small-pox Hospital of London. It states the death-rate among different classes

of patients: (1) the unvaccinated, and (2) the vaccinated. But the vaccinated have been divided into different sets according to the number of vaccination marks or scars found on their persons.

Of unvaccinated, there died ...	35 out of every 100
Of those said to be vaccinated but having no mark, there died about	23 ,, ,, 100
Of vaccinated—	
Showing 1 mark, there died nearly	8 ,, ,, 100
,, 2 marks, ,, ,,	5 ,, ,, 100
,, 3 ,, ,, ...	2 ,, ,, 100
,, 4 ,, ,, ...	1 ,, ,, 200

These figures are confirmed in the experience of other hospitals. It appears thus that the more thorough the vaccination the more complete the protection, and that that amount of vaccination is safest which leaves four well-marked scars.

It has been shown that the protective power of vaccination diminishes after the lapse of years. That objection is easily met. It is only necessary to have the vaccination repeated whenever necessary. (See Re-vaccination, p. 410.)

The gravest objection that has been urged against the practice is that vaccination has, in many cases, been the direct cause of serious disease. It is quite true that carelessness and want of cleanliness on the part of parents towards their vaccinated children may result in serious inflammation, erysipelas (rose), &c., of the vaccinated arm. But filthiness will render a pin-scratch a serious affair, and it is monstrous to suppose that parental neglect is to be an objection to a method for protecting the lives, not of one here and there, but of the whole community from a disgusting and fatal disease. Unfortunately there can be no doubt that syphilis has been communicated by vaccination. It has been shown, however, that pure vaccine matter taken from a syphilitic child cannot communicate syphilis to another child. It is only when the vaccine matter *is mixed with the blood* of the diseased child that risk arises. There are, therefore, two safeguards against such a danger, one is the evidence to the eye that the matter about to be used has no trace of mixture with blood, the other is due care in the selection of a healthy child from whom the matter is to be obtained. In short, care on the part of both parent and vaccinator are two absolute safeguards against the possibility of any danger arising from the practice.

But it would require proof of even greater dangers to justify any attempt to set aside a practice which has effectually subdued a disease that has swept away whole populations, and has every now and again made attempts to reassert its old evil dominion. The compulsory adoption of the practice is justified by the fact that every unvaccinated person is a danger to the community in which he lives. If the person who refused to be vaccinated endangered only himself he might be left till time and small-pox taught him his folly, but when it is remembered that every small-pox patient may be a source of infection to multitudes, a community is entitled to decree that no man shall be permitted to dwell in its midst without adopting the recognized precaution against the disease. "The wheel of time brings back the follies of the past oftener than its wisdom," and objections that were met and answered two-thirds of a century ago still find people prepared to urge them. Anyone who carefully examines the many documents on vaccination that are open for reference, can arrive at this conclusion only, that the opposition to vaccination can find supporters only among the grossly ignorant or the wholly irrational.

Rules for Vaccination.—Every child ought to be vaccinated within a very few months after birth. If the child is well and strong it is good to have it done by the third month, before the troubles of teething begin. *If, however, small-pox be in the neighbourhood no age is too early.* If the child be sickly or recovering from some sickness it ought to be postponed for some weeks till strength returns. Not less than two well-marked pocks should be produced, but four give the greatest degree of safety. Many people prefer to have their children vaccinated with matter from the cow, and there is, of course, no objection to this if the child be vigorous. For it is to be noticed that the effects of the cow's matter are more marked than those of matter passed through the human subject. But if the child from whom the matter is taken is thoroughly healthy there is no risk in the use of such matter, and it is as effective for the purpose. The arm which has been vaccinated should be carefully protected from rubbing and injury, and perfect cleanliness observed. Care should be taken that clothes do not press unduly up into the armpit to interfere with the natural flow of blood in the part. Many people employ shields for protecting the parts from rubbing. This can be quite as well done without such a contrivance. Moreover, the tapes used for tying on the shields are seriously apt to interfere with the circulation and cause a much more than usual degree of swelling in the arm. Wherever small-pox is prevailing all persons above ten at the utmost,

who were vaccinated in childhood, should be re-vaccinated, and naturally no time should be lost in having vaccination performed on any who have never undergone the procedure.

Re-vaccination.—It is extremely desirable that all persons who have been vaccinated in childhood should be vaccinated again before the twentieth year as a matter of course, but where any risk of infection is present, the second vaccination should be performed by the tenth year. Small-pox among adults who have been re-vaccinated is practically unknown. But, after the lapse of years, the protection against small-pox to those who have undergone the process only in childhood diminishes, though if they were attacked the disease would always be milder.

Chicken-pox (*Varicella*) has been supposed to be a mild form of small-pox. It is not so, for an attack of small-pox does not protect against chicken-pox, nor the latter against the former, although one attack of chicken-pox protects against a second. It is highly infectious; and children mainly suffer. The infection is caught from one to two weeks before the disease shows itself. That is, its period of incubation or hatching lasts that time.

Symptoms.—The disease shows itself by some degree of feverishness, restlessness, loss of appetite, and within twenty-four hours rosy-red pimples appear on the face, head, chest, and other parts of the body. These speedily become blebs, filled with clear fluid and surrounded by a ring of inflammation, enlarging till they may be equal to the size of a split pea. Within a week the blebs pass through the stage of pustule, that is, the clear fluid becomes changed into yellow matter, and dries up into dark-coloured scabs. By another week the scabs have fallen, leaving red marks, which last for a time. The rash does not come out all at once, but in crops, so that for three or four days one set follows another. They may appear on the sides of the mouth and tongue. In ten days or a fortnight the disease has run its course. The disease has no evil results, though the child may remain weakly for some days after its disappearance. (Eruption is shown on Plate VII.)

Treatment.—The child should be kept in one room, and have ordinary mild diet, milk, &c. No medicine is necessary. Separation from other children ought to be insisted on, as the disease is so infectious.

Typhus Fever is a very infectious fever. The infection seems to come off from a patient in the breath, and not, as in typhoid fever, in the motions from the bowels. The infectious matter, however, does not seem to thrive in the open air, nor does it attach itself to clothing, &c., or retain its poisonous characters as that of scarlet fever does. For free ventilation and plenty of fresh air are not favourable to the spread of typhus. It is probably for this reason that typhus is largely a disease of the poor, especially of the poor crowded together in small, ill-ventilated, and dirty houses. It is specially common in overcrowded parts of the poorer districts of towns in Great Britain and Ireland. It attacks both sexes almost equally, and at all ages, though the majority of those attacked are between the ages of ten and thirty. The greatest number of cases occurs during the winter and the smallest during summer, perhaps because in the winter the very poor huddle together for warmth, and the condition of overcrowding is thus readily produced. It usually attacks the same person only once, although there are cases of the same person suffering from it twice or even thrice.

Symptoms.—Between five and twelve days may pass after the person is infected before the symptoms of the disease appear. The first symptoms are shivering, headache, loss of appetite, thirst, and perhaps sickness, general weakness, quick pulse, and increased heat of skin. The bowels are bound. A noticeable symptom is dulness and heaviness of the patient, who has a stupid confused look, and cannot fix his mind upon anything; and sleep is disturbed. About the fifth or seventh day the rash comes out (Plate VI.). It is apt to be mistaken for measles, but the spots, which are of a dusky red colour, are not so large and raised as those of measles. It appears first on the sides of the chest and belly (measles appears first on the forehead round the edge of the hair), and on the hands, wrists, and elbows, spreading over the body, arms, and legs in a couple of days, but not marked on face and neck. After coming fully out it remains out for two or three days, and then begins to fade, disappearing by about the fourteenth day. In bad cases dark-coloured spots, due to the escape of small quantities of blood in the skin, may be present after the true rash has faded. During the second week of the illness the symptoms become worse. Delirium becomes constant, though, if sharply spoken to, the patient may be recalled to himself for a moment. Sometimes the delirium is violent, sometimes of a low muttering kind. As the disease progresses the tongue becomes dry and brown, the pulse faster and weaker, and the general weakness so marked

that the patient lies well down in the bed, on his back, with mouth and eyes half open, and motions and water are passed in the bed unconsciously. Often the hands wander aimlessly about, picking at the bed-clothes, a sign of great prostration. About the fourteenth day, in favourable cases, the turn of the fever is shown by the patient falling into a gentle sleep, from which, after some hours, he awakes quite sensible, with the fever almost gone, but in a state of extreme weakness. With careful nursing he goes on showing signs of improvement in returning appetite and gradually increasing strength, so that at the end of three or four weeks he is quite restored. If the case is going to end unfavourably the prostration increases, and instead of the turn at the thirteenth or fourteenth day, deep unconsciousness sets in, the fever runs up, and the patient sinks under it. Convulsions may occur, in such a case, before the unconsciousness comes on. The case may be milder than has been described, the delirium being limited to a "wandering," or it may be much worse, death taking place within the first week, instead of towards the end of the second, the usual time in fatal cases.

Ten out of every hundred is about the death-rate in typhus fever, and the deaths under twenty are fewer than those above it.

The chief complication in typhus is congestion of the lungs, largely brought on by the intense weakness produced by the disease.

Treatment.—The patient should be treated in a large well-aired room, fresh air being in this case the best disinfectant. He should be kept strictly to bed to reserve the strength. For maintaining the strength careful feeding is necessary. Sips of milk, beef-tea, nourishing soups from which all vegetables have been strained off, should be given *at short intervals*. The patient will in this way be induced to consume a large quantity in twenty-four hours, which he would not otherwise take. Thirst is to be relieved by barley-water, lemon-juice in water, or plain water. An occasional dose of castor-oil may be necessary to relieve the bowels, and at proper intervals the patient must be told to make water, since the intense listlessness of the patient may lead him to fail to do so. Sometimes the water requires to be drawn off. *The patient must never be left unwatched.* Delirium, which sometimes needs restraint, is to be met mainly by quiet, darkening the room, and applying cold cloths to the head. Stimulants, though not always necessary, are sometimes of great use towards the end of the second week, when the weakness is extreme, specially if the pulse is very fast and weak. They are doing good if the pulse becomes less frequent and stronger. The best stimulant is perhaps wine, to be given in tea-spoonful doses at intervals to the extent of two wine-glassfuls in twenty-four hours, or brandy or whisky in milk, half a wine-glassful to be mixed with a breakfast-cupful of milk, and given in doses of two or three tea-spoonfuls at a time, the whole cupful to be given in twenty-four hours. If cough, spit, and increased difficulty of breathing indicate congestion of the lungs, stimulants are to be used in this way. Twice the quantity noted may, in such a case, be given in twenty-four hours if it seems doing good. During the period of extreme weakness the attendant must guard against bed-sores by keeping the patient scrupulously clean, and by changing his position occasionally, so as to prevent the same parts being constantly pressed upon. During recovery strength is to be aided, not by stimulants, unless really necessary, but by careful nursing and feeding, frequent small quantities of nourishing beef-tea, soups, &c., being given.

Typhoid Fever (*Enteric Fever—Intestinal Fever—Bilious Fever—Gastric Fever*). Up till 1840 two fevers were confounded under the term *typhus* fever, but that two essentially different diseases were included under the one name was pointed out at the time mentioned by Dr. A. P. Stewart. Later a complete distinction was drawn between the two by Dr. William Jenner, the one described in the preceding paragraphs retained the name typhus, and to the other, because it was very like typhus in many particulars, the name *typhoid* was given. This fever (typhoid) is accompanied by serious disease of the bowel, and consequently to it the name enteric fever (from *enteron*, Greek for the bowel) has been given by some who do not like the confusion that two words, so like one another as typhus and typhoid, may occasion. The phrase "intestinal fever" is thus simply another phrase for "enteric" fever. Further, this fever is marked by sickness and by very decided diarrhœa or looseness of the bowels, and thus as the symptoms marked out the stomach and bowels as the chief seats of the disturbance, the name *gastric* fever has also been used for it. This term is not now being used by modern physicians, for it is essentially a bad one. Typhoid fever is an extremely serious and a very commonly fatal disease, but there may be many

disturbances of the stomach, accompanied by fever, but attended by no risk, to which the term "gastric fever" might be applied by some. It is a matter of the utmost moment that wherever typhoid fever exists it should be discovered; and the use of any term that would in any way tend to disarm suspicion as to the true nature of the disease is undesirable. It is quite certain that two diseases are very often confounded under the phrase gastric fever, namely, gastric catarrh (described on p. 158) and typhoid or enteric fever. Typhoid fever is often accompanied by severe vomiting, in which bilious matters are vomited, and hence some have called it *bilious fever*.

The **cause** of typhoid fever is almost certainly some living organism or germ, such as have been described on p. 393. No one, however, has as yet been able to separate the actual living thing which produces it. There is, nevertheless, sufficient evidence to lead to the conclusion that the poison of typhoid fever is not cast off from the body of the person sick of the fever, by the breath or by the skin, as occurs in measles, scarlet fever, and small-pox. This disease is, on this account, not infectious in the same way as the others mentioned are. It seems quite clear, on the other hand, that the typhoid fever poison is cast off from the bowels in the motions passed from them. It is also clear that the poison consists of living particles, and that, if they cannot live and multiply in the air, they can and do multiply in water. Thus the discharges from typhoid fever patients, cast into drains, find in the pipes and cesspools, particularly if they are not properly flushed with water and if they are blocked so that the refuse is stagnant, most favourable circumstances for their growth. It is also certain that drainage from a dung-heap, on which discharges from a case of typhoid fever have been thrown, getting into a well, can poison the water so that every one who drinks of it is liable to be attacked by the fever. It has been proved to be thus that typhoid fever suddenly appears and spreads among the population of a town, becomes, that is to say, epidemic. Happily the causes of such epidemics have been carefully traced. The history of them has been discovered again and again, and it is commonly something like the following. In a dairy farm one of the persons takes ill of fever, and is ill for several weeks at least. There is no particular medical attendance, and the character of the fever is not known by the farm people. The discharges from the sick person are thrown on to a dung heap or thrown out carelessly anywhere. Drainage from this gets into the well. The water from the well is used to wash the milk vessels, and probably to dilute the milk, and the milk is sent into the neighbouring town. The fever poison has multiplied in the well, has got into the milk with the water, has multiplied in the milk, and has been thus introduced into the stomachs of a certain number of the towns-people, among whom, in a short time, there is an outbreak of the fever. If, then, typhoid fever is not infectious in the same way as measles, scarlet fever, &c., it is at least infectious to this extent, that people eating food or drinking water, milk, &c., containing the poison are likely to take the disease. These facts are of immense practical importance, since they show that a person may attend on a case of typhoid fever without fear, if care be taken that all discharges from the patient, and all linen soiled with them, are carefully disinfected and disposed of.

Typhoid fever may occur at any age, though it becomes less frequent as age advances. No class or condition of men is free from its attack. It is most frequent in warm seasons of the year, and least frequent during cold weather.

It appears that some persons are able to resist the influence of typhoid fever poison much more successfully than others, so that not only must the poison be introduced into a person's body, but the person must be in a favourable condition for its growth within him. A lowered state of general health, from whatever cause arising, is undoubtedly one of the most favourable conditions for the attack of this disease as of many others. While one attack of the disease seems to afford some protection against a second, many second attacks have been recorded.

Symptoms.—It is uncertain what time elapses between the period of the introduction of the poison into the body and the commencement of the disease. It appears to be about three weeks. The disease usually begins by the person feeling unwell, and losing appetite. The loss of strength and general feebleness are marked. He complains of feeling chilly and then of feverish turns, of being drowsy, troubled with headaches, and of restless sleep at night. These are all vague general symptoms. But there are also disorders of the stomach and bowels, vomiting and looseness. These are often the most striking symptoms, and should make one suspicious. The temperature of the person should be taken. It will be found higher than usual (see p. 10). The pulse will be found fast, and the tongue

coated and brownish down the centre. One symptom should be tried for. It is pain on pressure in the right groin. If one presses this part with the fingers, generally gurgling will be felt, and the patient complains of some degree of pain. If the bodily heat be determined by the thermometer as described on p. 10 it will be found that the fever is highest at night and is lower in the morning. This daily rise and fall of the fever is peculiar to this disease. The rash comes out in the second week of the disease. It consists of rose-coloured spots about the size of a pin's head, raised above the skin, found principally on the chest, belly, and back. (They are represented on Plate VI.) They come out, only two or three at a time, in crops, and they fade in three or four days. But one crop after another continues, till the end of the third week. At this period (the second week) the tenderness of the belly and looseness of bowels are more marked. The motions may be very frequent and resembling pea-soup. The other symptoms continue, and the tongue is dry and tends to crack on the surface. Towards the end of the second week the fever continues, the tongue is more dry and brown, pulse faster and more feeble, the person grows dull and listless, is very prostrate, and there is delirium. The delirium may be violent, or simply rambling, or muttering. In the course of the third week the weakness becomes excessive and bed-sores are apt to form. The patient tends to slip down in bed. The body is wasted, the lips trembling, the pulse is extremely feeble and quick. Irregular starting of the limbs occurs, and the hands wander aimlessly about, picking at the bed-clothes. Blood is frequently passed in the stools. If the case is going to end in death, the starting of the limbs and wandering of the hands are marked, the motions and water are passed unconsciously in bed, and stupor comes on. A favourable turn is indicated by a gradual fall in the fever, a less frequent and more distinct pulse, a passing off of delirium, cleaning of tongue, and stoppage of looseness of the bowels. Recovery is always gradual and very slow. Many months may occur before strength is re-established. Relapses are not uncommon, attended by rash and all the other symptoms of the disease. They occur usually about ten days after the disappearance of the fever of the first attack.

While the symptoms that have been described are those of a typical case of typhoid fever, it must be observed that cases are very numerous where the symptoms are very obscure, and where, in consequence, the disease is apt to be overlooked. A patient, for example, may complain of chilliness and feverishness, of headache and unaccountable wearied-ness, of loss of appetite, and sleeplessness at night, and may exhibit no marked looseness of bowels, no spots on the skin, and no symptom pointing out typhoid fever with any certainty, while it is this disease which is attacking him. He may fight against his feelings of illness for seven or eight days, and then speedily succumb to the disease. Perhaps some great and sudden discharge of blood from the bowels occurs, or other grave sign of the mischief going on in the bowels. In all such cases the vagueness of the symptoms must not be allowed to make one indifferent. If the temperature is taken as advised (p. 10) it will probably give such warning as ought to lead to the person being sent to bed and being subjected to careful nursing and watching.

The **complications** of typhoid fever are numerous. The looseness of bowels indicates serious mischief there. It is found that the bowels are the seat of patches of ulceration occurring in the position of the glands of Peyer (p. 140). Now, in the process of ulceration a blood-vessel may be opened and fatal loss of blood may occur. The bursting of the vessel may be due also to improper exertion or to the taking of some hard food. In severe cases the blood is passed unaltered or in clots. Usually it is altered and makes the motions black and offensive. Where the loss is sudden and great it is known by the sudden paleness of the patient, and the failure of the pulse, and fainting. Bleeding may occur between the middle of the second and the end of the fourth weeks. Another danger is that the ulceration may eat through the bowel wall into the cavity of the belly, and there set up fatal inflammation (peritonitis, p. 190). It is shown by rapid swelling of the belly, violent pain, vomiting, great anxiety of the patient, and extreme frequency and feebleness of pulse. This occurrence is most common in the third, fourth, and fifth weeks of the disease.

Congestion and inflammation of the lungs are also exceedingly common.

Treatment.—As has been already said, many cases of typhoid fever present no marked symptoms. Nevertheless every suspicious case must be treated with watchfulness, and the mild cases with the same care as the severe. The patient should be put to bed and kept there. Often a person feels so comparatively well in the morn-

ing that he wishes to get up for a little. *This must on no account be permitted.* The patient should be daily sponged with lukewarm water, and the body and bed linen must be kept clean and dry and frequently renewed.

Perhaps the most important thing in the treatment of the case is the dieting. Only soft or liquid foods are allowed. Milk in abundance, beef-tea, light mutton broth, boiled bread and milk, lightly boiled egg switched, corn-flour, &c. &c. If the bowels are loose beef-tea tends to make them worse. This is to some extent corrected by the addition to it of rice, or thickening with corn-flour. *Overfeeding must be guarded against.* If the motions are mottled with white curd of milk, the quantity of milk supplied must be reduced at once, as these curdy lumps will seriously disturb the already inflamed bowel. *It is always best not to permit the patient to have much food at one time, but to give small quantities often.* Thirst afflicts the patient, and ordinary water in moderate quantities is not to be refused. Barley-water may also be given, and water made slightly acid with dilute sulphuric acid or ordinary vinegar.

As regards drugs, opening medicines must be cautiously given. At the very beginning a good dose of castor-oil may be administered. The ulceration going on in the bowel must be remembered, and if, later, the bowels require relief, it is best to give an injection of soapy water or weak tea of chamomile flowers. Looseness of the bowels, if excessive, is to be checked by the catechu and chalk mixture, with the addition of laudanum, if necessary, to a grown-up person. (See PRESCRIPTIONS—CHALK MIXTURE.) Bleeding from the bowels is restrained by a half to one tea-spoonful of liquid extract of ergot (spurred rye) if it is obtainable, to be given every two or three hours, as long as required. Failing that, 10 to 15 drops of turpentine every three or four hours, for several doses, may be given in a little olive-oil. Dilute sulphuric acid (10–15 drops) may also be given instead of these. If pain and swelling of the belly occur, the remedy is laudanum, 25 drops in water, repeated every two or three hours, to keep down pain. As to stimulants, they are never to be given as a matter of course. They are valuable only in the later stages of the disease when weakness is excessive, the pulse exceedingly feeble, &c. In such a case whisky or brandy is the best. It should be given in the following way: a wine-glassful of whisky is mixed with a breakfast-cupful of milk. Three or four tea-spoonfuls of the mixture are given at such intervals that the total quantity is not all used up for twenty-four hours. In extreme cases double this quantity may be necessary. But it should always be given in the way described, as thus one knows exactly how much is being given. The vessel containing the whisky and milk should of course be kept covered.

For weeks after the disappearance of the fever great care is necessary. Even in mild cases the person should on no account be allowed to sit up for a week after complete disappearance of fever, as shown by thermometer (p. 10). Even weeks after apparent recovery, improper exercise or improper food may lead to serious mischief in the bowel. All hard food should therefore be avoided for weeks after recovery.

These directions have been given for the benefit of any who may be in circumstances in which medical advice cannot be obtained. But the difficulties and dangers of typhoid fever even in its mildest form are so grave that only physical impossibility to obtain competent advice can justify any unskilled person attempting to take charge.

The fact that typhoid fever is contagious by means of the discharges from the patient must not be forgotten. Care must be taken to disinfect them in the manner described on p. 396. All linen also must be disinfected. In the country special pains must be taken that the discharges are not thrown where they may find their way into wells or burns from which a water supply is taken. It is in this way that contagion is spread, if the polluted water is used for domestic purposes.

Dandy-fever (*Dengue, Three-day Fever, Break-bone Fever*).—This is an infectious fever, not known in Great Britain, but occurring in India, Burmah, Egypt, Persia, North and South America, and the West Indies. It was first recognized in Rangoon in 1824, when it broke out among a body of troops. It attacks persons of both sexes and of all ages.

Symptoms.—The fever presents symptoms resembling rheumatic fever, scarlet fever, and ague. It often begins suddenly with severe pain in some joint, specially a finger joint. The pain jumps from one joint to another, soon attacking many. There are high fever with shiverings, loss of appetite, great weariness, sickness, and pain in the head and eyeballs. The rash comes out on the third day and is like that of scarlet fever, the face being red and puffy, the throat red and

sore, the eyes red, and a general redness being over the body. It is usually accompanied by itching. The pulse is frequent, breathing is quick, and the tongue is covered with a white coating out of which red points project. On the fifth or sixth day the rash passes off, and the fever falls, and comparative health is restored. This lasts, however, only for from two to four days, when the fever returns, and a second rash resembling measles or nettle-rash (p. 314) appears. The second attack lasts two or three days and gradually passes off, much of the scarf-skin often separating. Though the fever passes off, the pain and swelling of the joints, especially in the smaller ones, remain, and may continue to afflict the patient for weeks. Further, more than a second relapse may occur, making recovery slow and doubtful. In ordinary cases, however, eight days is the average length of the disease. In the course of the fever delirium, in children convulsions, may occur.

Treatment.—Gentle movement of the bowels should be regularly obtained, but there should be no purging. The ammonia and ether mixture (see PRESCRIPTIONS) should be given in tea-spoonful doses every two or three hours. The addition of tincture of belladonna is recommended, and two or three doses of from 5 to 10 drops may be given at intervals of an hour, the mixture being afterwards given alone. If the fever runs very high cold sponging is useful. The joints may be rubbed with opodeldoc (soap and opium liniment) or with a liniment of opium, chloroform, and belladonna. During recovery quinine tonics are of great help. The following may be used:

Quinine, ...	...	16 grains.
Dilute sulphuric acid, ...	...	2½ drachms.
Infusion of calumba,	to make	8 ounces.

Of this a tea-spoonful should be taken in a wine-glassful of water three or four times daily.

Food should be mild and nourishing, milk, light soups, rice, &c., and often change of air is very valuable in getting rid of the lingering affection of the joints.

INFECTIOUS FEVERS WITHOUT RASH (ERUPTION).

Influenza (*Epidemic Catarrh*).—This is an affection similar in its general characters to the disease described as catarrh (p. 154) or common cold-in-the-head. Indeed to cold-in-the-head, when accompanied by sharp fever, pains in the bones, and sickness, the name influenza is often applied. The true influenza is, however, remarkably infectious, which common catarrh never is. In fact influenza is one of the most remarkable of epidemic diseases, capable, as it is, of running through a whole community with marvellous rapidity. Thus one epidemic of it, in 1782, spread over all Europe, missing no country of it, affecting more than half of the people and killing many. Many epidemics of it have occurred since then. The infection is apparently conveyed by the air.

Its **symptoms** resemble those of ordinary catarrh. Its attack is very sudden, and is indicated by chills along the spine, and flushes of heat, high fever, pains in back and limbs, and perhaps sickness. The lining membrane of nostrils, eyelids, mouth, and throat becomes dry, red, and swollen. There are sneezing, intense pain in the forehead and eyeballs, inflammation of the throat and tonsils (p. 136), soreness of throat, harsh croupy cough, and a sense of tightness and pain in the chest. The skin is dry, the tongue white, the bowels confined, and the appetite is lost. The excessive weakness that is rapidly produced is a very marked symptom. In a short time the dryness of the nostrils yields, and a free discharge of watery material comes from them; there is also spit. About the same time the skin becomes more moist, and sweatings occur. Later the discharge from the nose and throat is mattery, and difficulty of breathing and cough are marked. A number of blebs occur on the lips very often. In about three or five days the attack passes off, usually with free sweating, leaving the patient extremely weak and afflicted with troublesome cough. The disease may, however, last several days longer, owing to inflammation attacking the tubes of the lungs and passing downwards, marked by increased difficulty of breathing, hoarseness, cough, and darkening of the face and lips, owing to the affection of the lungs. Bronchitis (p. 270) inflammation of the lungs, that is, pneumonia (p. 274), and other diseases may thus complicate the attack, and delay recovery or cause death. Though death is rare, it is from such complications that it arises.

Treatment.—The patient must be kept in bed in a room kept at a moderate and regular warmth. The kind of food allowed is milk, corn-flour, beef-tea, &c. In case of thirst, barley-water, meal-water, lemonade, soda-water may be given in ordinary quantities. At the very commencement the feet and legs of the patient should be placed in a hot bath containing sufficient mustard to produce a feeling of

tingling, and a hot drink should be administered. The following mixture is useful:

Solution of acetate of ammonia,	2 ounces.
Spirit of nitrous ether, ...	¾ of an ounce.
Ipecacuanha wine, ...	¼ of an ounce.
Water, ...	to 4 ounces.

Give a large tea-spoonful in water every two hours to grown-up persons, and less to children in proportion to age. For grown-up persons 4 drops of laudanum may be added to each dose, *but not for children.*

If the cough is very troublesome let a kettle be kept boiling on the fire and pouring its steam into the room; and if the throat and chest are sore apply hot poultices of bran or linseed-meal over the throat and upper part of the chest. The bowels should be relieved by seidlitz powders, or citrate of magnesia, or by injection. If the chest is seriously affected, hot poultices all over give great relief, and a cough mixture of ipecacuanha wine and squills (see PRESCRIPTIONS—COUGH MIXTURES) may be given. During recovery, nourishing foods, iron and quinine tonics, &c., are required. Stimulants are often required in the period of extreme weakness. Their use should be regulated by a medical man. If advice cannot be obtained, let 4 teaspoonfuls of whisky or brandy be put into a cup of milk, and let it be given in sips so as to be used up in 12 hours, when a fresh quantity should be made for the next 12 hours.

Hay-fever is described on p. 274.

Whooping-Cough.—This is specially a disease of children, though grown-up people may also be affected with it. Girls suffer more than boys. It is extremely common in children, standing next to scarlet fever as a cause of death. The greatest number of cases occurs in children under eight years of age, and it is more fatal in spring and autumn than at other seasons of the year. It is the most fatal of all diseases to children under one year of age, and three-fourths of all the deaths from it are of children under two years, while only six per cent of the deaths occur above five years. It is, therefore, a disease from which children under five years of age should be most carefully guarded. *It is an infectious disease,* the cause of the disease being given off in the breath of the person suffering from it, and being capable of conveyance by the air and by clothes also. It is specially infectious in the early period of the attack. One attack almost perfectly protects against another. Now taking these two facts together, the terribly fatal character of the disease among young children, and its extremely infectious nature, how great should be the care taken by mothers and nurses to prevent its spread and to protect their children from it. Yet it is the commonest thing possible to find mothers carrying children affected by it in public conveyances, tram-cars, and the like; and very insufficient pains are taken, when it appears in a household, to separate the affected child from the others.

Symptoms.—The earliest symptoms are like those of a common cold, with considerable fever. They begin probably a fortnight after infection has been received. The child is restless and feverish, pale and without appetite. Its breathing is quickened. It sneezes and has an irritable cough. The cough is very troublesome day and night, but specially at night. Fits of coughing come on; a quick short series of coughs ends in a long-drawn whistling breath, followed by another long cough. Some defluxion may be expelled at the end of the fit of coughing, and vomiting often occurs. After a week or a fortnight the fever lessens and the cough begins to be marked by the peculiar whoop, that gives the name to the disease. The cough still comes on in fits or paroxysms, in ordinary cases every hour, in severe cases every half-hour, and in bad cases even oftener. The child knows when it is going to come on by a tickling sensation. It becomes quiet and frightened, rushes to its mother or nurse, rises if it is lying down. The fit begins with a deep in-drawn breath, which is followed by a rapid series of short coughs, becoming weaker, till all air seems driven out of the chest; the face becomes swollen and bluish; the veins are seen full of blood; the eyes are starting, the skin wet with sweat; and the onlooker would believe that the child was choking, when the spasm, preventing the entrance of air into the lungs, begins slowly to yield, and as the air enters the narrowed opening in the windpipe, it produces a long, whistling, or crowing sound, the "whoop," of the disease. Two or three such attacks may occur quickly after one another, till the child is quite exhausted and faint. Often some defluxion is expelled towards the end of the attack, and vomiting is produced. The great strain on the blood-vessels may cause bleeding from the nose or other parts of the air-passages, and the eyes may become blood-shot. The child soon recovers and seems all right till another fit of coughing occurs. This stage lasts from four to six weeks or even longer, though sometimes it

may be only two weeks, and then the spasms become fewer and less severe and defluxion is more free. Health and strength gradually return, but complete recovery may often take many months.

The dangers of whooping-cough are the occurrence of bronchitis, of inflammation of the lungs, and of convulsions. The younger the child the greater is the risk of bronchitis rapidly overspreading both lungs. Without such complications recovery ought to take place, though death may occur during the spasm.

Treatment.—The child should be kept in a room constantly maintained at a moderate degree of heat. The air should be kept moist by steam from a kettle on the fire. The child should be clothed in flannel, and should get light nourishing food in small quantities often. The bowels should be kept regular by castor-oil or syrup of senna. The medicine to be given is bromide of ammonium and belladonna. Children stand large doses of belladonna, and the quantity may, therefore, be steadily increased in the following way: Let a mixture be made containing 64 grains of bromide of ammonium in one ounce of simple syrup (solution of sugar) and three ounces of water. Give a tea-spoonful of this every two or three hours. This is to be continued throughout the first week, and to it occasionally may be added four or five drops of ipecacuanha wine. When the second stage comes on, the same solution of bromide of potassium is to be used, and to each tea-spoonful, as it is about to be given, add one or two drops of tincture of belladonna. If the child stands this quantity well, after one or two days' experience, three drops of the tincture may be added to each dose, and after a further experience of a day or two with the three-drop dose, four drops may be added to each dose, and even five drops. As soon as the black of the eye appears very large no further increase in the quantity of belladonna is to be made. The object of the belladonna is to relieve the spasms of coughing, and as soon as they begin to yield, the quantity of belladonna is to be gradually diminished. To help recovery of strength when the disease is evidently over, nothing is so useful as change of air. This should not be sooner than six weeks after the commencement of the illness. As a tonic to aid recovery, a half to a tea-spoonful dose, according to age, of syrup iodide of iron may be given thrice daily. The infectious nature of the disease must not be forgotten, and disinfection should be practised as described on pp. 395 and 396.

Diphtheria and Croup.—These two diseases will be considered together, since according to many authorities, they are the same disease, which is called diphtheria when it principally attacks the tonsils and parts in their neighbourhood, and is called croup when it principally attacks the top of the windpipe—the larynx (p. 250).

Diphtheria is a contagious disease, the result of the introduction into the body of the person who suffers it of a particular poison. The poison may be harboured on clothes and so carried about. It is thus capable of spreading, of giving rise to an epidemic. In some places it is more or less constantly present, is, that is to say, endemic, probably because of some bad sanitary condition. It occurs in every climate and season. It may attack persons of any age, but is most common between the ages of two and ten years. It seems to have some relationship to scarlet fever, for in many cases diphtheria occurs after scarlet fever.

Symptoms.—The disease begins to show itself within a few days after the poison has been received into the body. But the symptoms may be so ill-defined and vague that the disease is far advanced before the patient really appears seriously ill. The symptoms at the commencement are chills and feverishness, loss of appetite, general weakness and dulness, and marked paleness of skin. Sometimes in the child the first thing that attracts attention is a complaint of soreness of throat. When the throat is examined, already there may be seen the presence of white patches that too surely indicate the nature of the disease. These are patches of false membrane, of a dull white or grey colour, like pieces of wash leather. They are placed on the tonsils and neighbouring parts of the back of the throat. The patches are small to begin with, but they tend to spread and join one another, so that in severe cases the whole back of the throat, including tonsils and uvula (p. 136) is covered with the membrane. If the membrane be scraped it separates in shreds, but grows on again. The throat is also considerably swollen; indeed, even though only one side is attacked, the swelling may be so great as almost quite to block the passage. The glands at the side of the jaw are also swollen. As a result of the swelling there is difficulty of swallowing, though the attempt to swallow does not produce the intense pain common in a severe attack of quinsy (p. 155). In many cases swallowing can be performed all through the illness. The swelling and loss of appetite com-

bined render the patient not inclined to take food, and in children this is a cause of much trouble. For a marked feature of the disease is the excessive prostration it produces. It is to combat this that remedies are, from the first, directed; and so where disinclination to swallow exists, there is great difficulty in getting sufficient food taken to maintain the strength. The disease may not go beyond the stage described, and in ten days or a fortnight recovery begins, the membrane separating in pieces, and being spat out or in young children swallowed. The breath is frequently very foul, because of the decomposition of the false membrane. Even after the throat is quite clear and clean, the patient remains extremely feeble, and in some cases the voice is altered, perhaps lost for a time, owing to paralysis.

But the membrane may extend up into the back of the nostrils and down the gullet towards the stomach, and the disease may be so prolonged that the patient dies of exhaustion.

A most frequent and the most fatal form of the disease is that in which the formation of the false membrane proceeds downwards into the windpipe. The symptoms of this occurrence are those of **croup**. The voice is hoarse, and there is a short dry cough of a peculiar character. It is hoarse and muffled, "like the distant barking of a puppy." Sometimes it is a brassy sound. Accompanying the progress of the disease down the windpipe there is increasing difficulty of breathing. These signs are of the most serious nature, especially so in children, in whom the passage of the windpipe is narrow and easily blocked. As the membrane thickens the voice is lost, and the cough becomes muffled and almost noiseless. Suffocative fits come on, partly due to spasm, partly to the membrane blocking the air-passage, and the patient struggles for breath, the face becoming blue and the eyes staring. One fit passes off, and the patient becomes easier, but speedily another comes on, the person at last sinks into a state of exhaustion and stupor, and death occurs. Usually the end happens before the fourth or fifth day after the symptoms began. Now, sometimes the disease attacks the air-passage only, without any previous attack of the tonsils, no white patches being seen at the back of the throat. In very young children the formation of the membrane in the windpipe may proceed so quickly that death occurs within a few hours of the hoarseness and cough indicating the disease.

The membrane may also pass up into the nostrils from behind, and be evidenced by stopping of the nostrils and discharge of matter and blood.

Further, there are cases of diphtheria in which death occurs within a few days, even in grown-up persons, not from suffocation, but from the violence of the poison and the exhaustion produced. Indeed, death may occur without any apparent formation of membrane, and so rapidly as to leave some doubt regarding the true nature of the disease.

Nor yet is all danger passed when the throat affection has passed away, for death may even then suddenly occur from loss of blood, failure of the heart, and other causes.

Treatment.—The person is to be put to bed in a large well-ventilated room, which must be kept continually at a moderate heat, and in which no draughts must be permitted. A fire must be kept on constantly, and a kettle should always be on the fire pouring its steam into the room. If the least suspicion of the throat being affected is present, the kettle should be a bronchitis kettle (see MEDICAL AND SURGICAL APPLIANCES), and the steam should be plentifully poured in the immediate neighbourhood of the bed. If the bowels are confined castor-oil must be given, or an injection. From the beginning every effort should be directed to maintain the strength, sips of warm milk or warm beef-tea, strong mutton-broth, freed from fat and vegetables, eggs beat up in milk, &c., should be administered in small quantities often. Port wine in small quantities is also to be frequently administered. Cold drinks are not to be withheld, and ice may be given to suck. When the patient cannot swallow nourishing injections become necessary. The method of administering them is explained in another part of this work. (Refer to index for INJECTIONS.)

The treatment by medicine is twofold. The throat must be regularly painted several times daily, in the hope of arresting the growth of the false membrane, and a mixture is to be given. The paint is made of equal parts of glycerine and liquor of perchloride of iron—the strong liquor. To each ounce of this one drachm of sulphurous acid is added, and the whole shaken together. A brush is used—camel's hair or goose quill—firmly set on a long handle. The tongue of the patient is held down by a spoon, and the back of the throat thoroughly painted over. The painting must be repeated twice or thrice daily. With children it is difficult to accomplish, and help is necessary. A new method consists in drying the throat as well as

possible and then painting it with Tolu varnish. The following mixture is to be given:—

Chlorate of potash in powder, ...	120 grains.
Solution of dialysed iron, ...	½ ounce.
Syrup of orange, ...	1 ounce.
Water, ...	to 4 ounces.

Of this from a half to one tea-spoonful is to be given four or five times daily. When suffocation is threatened steam is to be kept streaming about the bed, and hot cloths may be applied on the neck. A surgeon would probably suggest opening the windpipe by the operation known as tracheotomy (p. 270). During recovery quinine and iron tonics, nourishing foods, cod-liver oil, and, when the patient can bear it, removal to the sea-side, are valuable aids to full restoration of health.

Disinfection (p. 395) must not be forgotten.

Croup, true croup, has been considered in the preceding paragraphs as an extension of diphtheria down into the top of the windpipe—the larynx (p. 250), or into the windpipe itself; or it may be the diphtheria attacks the larynx and windpipe first and directly. There is, however, an ordinary inflammation of the top of the windpipe and windpipe itself not attended by formation of false membrane, to which children, of two and three years old, are specially liable, to which the term croup is also applied.

Its **symptoms** may come on suddenly with alteration of voice, some hoarseness, and frequent dry short cough. The cough speedily takes on special characters, it becomes barking and "brassy." There is fever with difficult and hurried breathing, crowing and piping noise with taking in of breath, quick pulse, and the child is restless and anxious and plucks at its throat. Now it may be impossible to say whether the symptoms are due to the formation of a false membrane in the windpipe, as in diphtheria, or to inflammatory swelling. Death may occur by suffocation or exhaustion, and very speedily.

Croupy symptoms are often present at the commencement of measles.

The **treatment**, in so far as it differs from actual diphtheria, is the same as that described on p. 270 for inflammation of the larynx, and consists principally in the use of hot poultices and cloths over the front of the neck, and the use of steam, hot drinks, &c.

Relapsing Fever (*Famine Fever—Bilious Remittent Fever—Seven-day Fever—Irish Fever*).—This is a fever that seems to be related to periods when extreme poverty prevails, hence its term famine fever. So far as Great Britain is concerned, it came from Ireland, and hence was called Irish fever; but it has also appeared in America, India, Africa, and Russia.

It is undoubtedly due to the presence of a living germ in the blood, is contagious, and may be carried long distances by infected persons and by clothes.

Symptoms.—It is doubtful what period passes after the poison has been introduced into the body before the attack begins, sometimes apparently only a few days, at other times about a fortnight. The attack begins with shivering fits, pain in the forehead, back, and limbs, high fever and great dryness of skin. Appetite is lost; there is thirst; the pulse is very fast; the tongue is covered with a thick white coating, the tip and edges being red. The bowels are confined; there is pain over the stomach, and to the right side over the liver; and vomiting occurs. Jaundice, yellowness of the skin, occasionally appears about the second or third day, hence the idea that the fever is a bilious one. The pains in the joints are of a rheumatic character. Towards the end of the first week there may be delirium. In from five to seven days from the beginning of the attack the fever suddenly passes away, usually after copious sweating, lasting for a few hours, or after free discharge from the bowels. The other symptoms also disappear, but the patient is left weak. For about a week he remains apparently well, and then a second attack suddenly comes on, similar to the first, lasting about three days, and ending like the first. A third attack may follow. Purplish spots may appear during the disease, though there is no regular rash.

Deaths from relapsing fever are not common. Weakness produced by the fever is great, and recovery is slow. The complications apt to occur are affections of the lungs and bowels, looseness, and dysentery.

Treatment.—Light food of milk, corn-flour, beef-tea thickened with rice or corn-flour, is to be given in small quantities. Cold sponging, when the heat is great, with water containing a little vinegar, is refreshing. The patient may have ice to suck, and tea-spoonful doses of the following mixture are to be given every three hours:—

Solution of acetate of ammonia, ...	2 ounces.
Spirit of nitrous ether, ...	¾ of an ounce.
Water, ...	to 4 ounces.

To relieve pains and help sleep 5 drops of laudanum may be added to each dose, *but only to*

grown-up persons. The bowels should be moved by castor-oil or by injections. No medicine prevents the relapse. Recovery is to be aided by light nourishing foods, and quinine tonics.

The contagious nature of the disease must be remembered, and the rules for disinfection (p. 396) followed.

Plague (*Pestilence—The Pest—Black Death*).—This is a disease believed to have been observed as early as the second century before Christ. It was common in Egypt, other parts of Africa, and Asia. In the sixth century after Christ it spread over Europe. From that time it continued to exist in Europe, breaking out at intervals in fierce epidemics. Towards the end of the seventeenth century it began to disappear from Europe, from which, however, it had not quite departed till 1841. The last attack in Great Britain was the Great Plague in London of 1665. It seems still to exist in Arabia, Persia, and other parts of Asia. Starvation, filth, and overcrowding are the conditions that favour its spread. It is extremely contagious, being communicated by the breath and carried about by clothing. In many respects it resembles typhus fever.

Symptoms.—The disease appears about five days, on an average, after the poison has been taken into the body. The following are the chief points of the description given of it. It begins with shivering fits or chills, with fever, pain in the forehead, back, and limbs, and great weakness of body. The patient wears a dull, stupefied haggard look. From the second to the fourth day of the disease swellings of glands (buboes) appear at the angles of the jaws, in the armpit and groins. The eyes are red, skin hot, tongue as if covered with wool, or dry, black, and cracked. The gland swellings cause pain, and come to matter if the patient does not die before. In some cases boils or carbuncles appear on the limbs generally, and purple spots (*petechiæ*) are not uncommon. Sickness and vomiting of bilious matter and perhaps bloody matter are frequent.

Death within twenty-four hours of the beginning of the attack is frequent, and the majority of deaths occur within four or five days. The death-rate is not less than one in three.

Treatment is similar to that of typhus fever. No treatment that can cut short the disease is known. Disinfection and avoidance of the conditions of the spreading of the disease, uncleanliness, overcrowding, &c., are the means to prevent its extension.

Yellow Fever (*Black Vomit—Yellow Jack*) is a disease of hot climates, common in the West Indian Islands. It has been introduced into Europe, but does not tend to spread except in times of great heat. Cold kills it. It attacks Havana almost yearly between the months of April and December. It is rarely absent from the West Indies, and is most fatal from May to August. It is a contagious disease, and its contagion can be carried by clothing, and conveyed by infected ships. A person who has suffered from one attack is safe from a second.

The **symptoms** may appear within one or two days after the poison has entered the person's body, or may not occur for six or ten. The attack is sudden, beginning with shivering, fever, dry skin, intense headache, pain in the back and limbs. The eyes are glistening, bloodshot and red; the face is congested; there are great thirst, loss of appetite, tenderness over the stomach, sickness and vomiting. The tip and edges of the tongue are very bright red, the rest being covered with a white coat. The lips and throat are also bright red. The pulse is at first very fast, but may greatly diminish in speed, even while the fever remains high. The fever may not remain high for more than a day or two, but the vomiting and tenderness over the stomach continue. At first the vomit is of the contents of the stomach, then it becomes coloured with bile, and later has a "coffee-grounds" appearance, the black vomit, due to mixture of altered blood. The motions are often black for the same reason. By the second or third day of the disease the whites of the eyes may be seen to be yellowish, and the yellowness spreads to the face and over the body, the jaundice being well marked. The urine, which is at first clear and of the usual quantity, becomes, with the advance of the disease, of a deep yellow from the presence in it of bile. The colour may deepen to orange red, and at the height of the attack almost no urine may be made. In favourable cases the quantity becomes large and the colour becomes very dark. Death may take place within a few hours of the attack from the violence of the poison, the person becoming collapsed. It may occur at any time in the progress of the disease, the fifth day being regarded as critical. In cases that have gone on for several days death is usually due to bleeding from the stomach or bowels or kidneys, or from exhaustion of the heart. Where recovery takes place it is gradual, and the jaundice takes long to disappear. The death-rate is very high.

Treatment.—The patient should be confined

to bed and all exertion strictly forbidden. The room should be large and well-aired, but kept constantly at a moderate warmth. The bowels should be relieved by injections. Corn-flour, beef-tea, chicken broth, milk, and similar food should be given at regular and short intervals. Large draughts of lemonade and barley-water are to be allowed. Ice is to be sucked to allay sickness, and for the same purpose mustard poultices are applied over the stomach. In cases of recovery the person must not be allowed to sit up till fourteen days have passed.

It is needless here to mention any of the many drugs tried for the disease. All discharges from the patient must be at once disinfected, as recommended on p. 396, and removed, and other steps taken to limit the disease (see p. 396).

Hydrophobia (*Dog-Madness—Rabies*).—The word hydrophobia is derived from two Greek words, *hudōr*, water, and *phobos*, fear, the dread of swallowing and the spasms produced by the attempt being a marked feature of the disease. It is a disease to which dogs, cats, wolves, and foxes are liable. It is due to a particular poison, which seems specially to exist in the saliva or spit of the animal affected by the disease. It can only be produced in human beings by the direct introduction of this material into the body by a bite or other wound. A person may be bitten by a dog and may in consequence be seized with the disease, although the dog did not at the time show signs of the disease. Cases have been due to a dog, not known to be suffering from the disease, licking the hand of its master on which some slight wound was present. The bite of a cat may produce it. Probably, however, not more than a third of the persons bitten by mad dogs take hydrophobia, even when no attempt has been made to destroy any poison that may have been imparted from the dog's mouth. When the bite has been through clothes the risk is less than if the part of the body had been uncovered. More men suffer from the disease than women. There seems no doubt that a bite from a healthy dog cannot produce the disease. A dog must be suffering from the poison, whether it is evident or not, before it can impart the disease to another.

Symptoms.—It is very doubtful how long the poison requires to reside in the body before the disease appears. The shortest interval between the bite and symptoms has been about twelve days. The interval is seldom less than a month, and is on an average six or seven weeks. In some cases many months have passed before the disease appeared, and some have been recorded in which the interval extended to years. The appearance of the disease after four months is, however, seldom. The wound by which the poison gained admission to the body usually heals as easily as an ordinary wound. It is said that among the first symptoms in many cases is return of pain to the place of bite, hot tingling pain, shooting from the part. Such is often not present. Other symptoms are restlessness, shivering, uneasiness, a feeling of illness, disturbed sleep, lowness of spirits, and discomfort about the throat with some difficulty in swallowing liquids in particular, while at the same time there is thirst. As the disease advances the patient becomes excited, the eyes look wild, and he wears an expression of terror, and is liable to outbreaks of delirious excitement in which he may strive to injure himself or others. The chief symptom is the spasm that occurs on attempting to drink. At first it is mere difficulty of swallowing, but soon the attempt causes a spasm, a "catch in the breath," which, in the course of a few hours, becomes marked as a strong contraction of the muscles of breathing, there being a strong effort as in taking in a deep breath, so that the shoulders are raised and the corners of the mouth drawn outwards. The spit cannot be swallowed. It collects in considerable amount, and hangs thickly from the mouth, a source of great annoyance to the patient. Even when the patient is quite conscious, the impossibility of swallowing is marked. The person may take a glass of water, and, making up his mind with great effort, may carry it quickly to his mouth with agitation, but the spasm comes on and the glass is violently thrown away, and any water that may have got into the mouth is violently thrown out, while the patient shudders, and marked spasms of the muscles for breathing occur. The very thought of drinking is terrifying. The mere sound of running water produces spasm, and the state of terror and agitation is extreme. In advanced cases any sudden noise, or a rush of cold air, will bring on a convulsive attack. As the disease advances the patient becomes feeble, the voice hoarse, and the convulsions more frequent and severe. Death occurs from exhaustion or from suffocation in convulsion. The disease is without exception fatal, death occurring in from two to six days.

In dogs the symptoms of rabies are sullenness, fidgetiness, and continual shifting of position. The dog seems to see things in the air, which he

gazes at, follows, and snaps at. His appetite is perverted. He swallows bits of coal, wood, &c. Saliva streams from his mouth, and hangs in sticky strings from it, disturbing him and causing constant efforts with paws to get rid of it. He makes a hawking noise in the effort to clear the throat and mouth. His bark is hoarse, and eyes bright. There is evidently intense thirst, and *the dog has no fear of water, for he often buries his muzzle in water at the height of the attack;* but he cannot drink owing to paralysis of muscles, or spasmodic irregular movements of them. He bites anything that comes in his way, and may thus in a short time infect other dogs, cats, and other animals. Finally the dog reels and staggers, his hind legs and lower jaw lose their power, and he dies in convulsions or from exhaustion.

It is to be noticed that nervous people, who have been bitten, may by mere mental anxiety work up symptoms resembling those of hydrophobia. This false hydrophobia may be known from the presence of anxiety alone and not delirium, from the spasm on drinking being a mere difficulty of swallowing, which can be overcome, and being overcome, does not return. In such cases if the patient's mind be set at rest, and some soothing medicine given, a 30-grain dose of bromide of potassium, for example, the symptoms disappear.

Treatment.—Whenever a person is bitten by a suspicious animal the circulation of blood ought at once to be stopped, for a brief period, in the bitten part by tying a tight band, if it be a limb, above the bitten part, and carefully washing the bite and allowing it to bleed freely. As soon as possible—immediately, if possible—the part should be burned. A hot iron, poker, &c., may be freely and deeply used, or nitric acid painted lightly over the place with a brush, and then wiped off with a sponge and cold water. Attempts to treat the disease have failed. Attempts may be made with chloral hydrate, in from 10 to 30 grain doses, to keep down the spasms. The patient should be kept very quiet in a dark still room. Persons in attendance ought to be careful, since a bite from a patient, or the spit of the patient cast on the attendant, may impart the disease.

Glanders and Farcy are diseases of the horse and of animals of the same species. They may be communicated to man by poison contained in the discharge from the nostrils of the diseased animals. It is, however, rare in man.

Symptoms appear from three to eight days after the introduction of the poison, and in some cases after a longer interval. They are high fever, great heat of skin, shiverings, quick pulse, pains in muscles and joints of a rheumatic character, headache, sleeplessness, profuse sour sweatings and clamminess of skin. The nostrils become congested, and a biting watery fluid comes from them, which soon becomes thick, and mattery. A rash, at first of red spots, like flea-bites, appears scattered over the face, limbs, neck, and belly. They become pimples like peas, grow yellow, and soon burst, pouring out matter, and leaving bad ulcers. The eyes yield matter; sores form in the mouth and throat, and the lungs become affected. Lumps, turning into boils, form in the skin on the face and in the neighbourhood of joints. The patient becomes very weak; delirium comes on, followed by stupor and death. The disease runs its course in sixteen days, on an average, but some cases end fatally in a week. It is usually fatal.

In glanders the nose and ear-passages are early affected. In farcy the poison is introduced in a wound on the body or limbs. The part becomes red and inflamed, glands in the neighbourhood become affected, and lumps (farcy-buds) and boils form in the skin. Both are, however, practically the same disease.

Treatment.—No curative treatment is known. The patient's strength must be maintained, as well as possible, by nourishing food and stimulants, and the affected parts should be carefully and regularly cleansed, abscesses opened and cleaned out, &c. A person attending a case ought to wear india-rubber gloves while bathing the affected parts.

Syphilis (vulgarly called *Pox*) is a contagious disease, is, indeed, a type of that class of diseases capable of being contracted only by the direct introduction of a special poison into the body of a person. The poison is, in this case, communicated directly by sexual intercourse or indirectly by inheritance. To this rule there are, however, exceptions which must be noticed, and will be stated in the course of the description of the disease. How the disease first originated, where, that is to say, the first poison came from, it is as impossible to state as to declare where the first poison of small-pox came from, or, for that matter, the first seed of corn or wheat or potatoes. When and in what place the disease first manifested itself it is equally impossible to decide. It appears, however, to have occurred in Europe, and certain parts of Asia, from the earliest times. It has spread

over the entire globe, by means of the commerce between countries, though there are yet some regions free from it. The disease is not affected by climate. During the latter part of the fifteenth century the disease assumed an epidemic form, and spread throughout the whole of Europe.

One attack of syphilis protects against a second, but then the disease does not run its course in the brief period occupied by other fevers, such as small-pox, scarlet fever, &c. Its progress occupies months, even years, and sometimes continues throughout the life of the person who has contracted it.

Symptoms.—The fearful character of this disease will be best understood by an account of the progress of an ordinary case, to arrest which no steps have been taken.

The first occurrence of the disease is the appearance of a sore, called the **hard chancre**, at the place where the poison has been introduced, usually some part of the genital organs. This sore, however, does not appear for a considerable time after the poison has been received. There is a period, that is to say, corresponding to the period of incubation or hatching of ordinary fevers, which has been referred to on p. 397. This interval is on an average four weeks. It may be only a little over two weeks, while, on the other hand, it may extend to nearly six weeks. During this interval there is nothing whatever to lead the person, who has exposed himself to the disease, to suspect the possibility of its existence. A person, whose conduct has rendered his infection only too probable, after failing to discover anything for a week or two, may conclude that he has (undeservedly) escaped, but this conclusion is not justified so early as this. The form which the sore takes on its first appearance is that of a small red dark-coloured pimple, which slowly grows larger. The person may be, and often is, unaware of its presence, since it is not painful nor itching. In a few days the pimple is broken by the separation of a part of the surface, and speedily a little ulcer is formed. The ulcer is of a peculiar character. It is not deep but shallow, and all round the sore is a firm ridge of a dark red appearance. If the part be taken between finger and thumb it has a hard feeling, as if a little mass of gristle had been deeply imbedded in the substance of the skin. The ulcerated surface is greyish, and rather dry, only a scanty thin discharge being produced by it. In about six weeks it reaches its complete formation, when it is about the size of a split pea, and it thereafter begins to diminish. When it is healed it leaves a white scar that will never disappear. The scar is below the level of the surrounding parts, which are somewhat hardened, and of a darker colour than is usual. So little trouble does this sore occasion, that the person may from first to last be ignorant of its existence. The sore is single; several of them do not occur on the same person. While this is the usual form and course of the sore, it may appear as a mere scratch or crack, healing easily and leaving scarcely any recognizable scar. What has been described is the true, hard chancre, the first result of the activity of the special poison of syphilis. But there is another sore, called soft chancre, or **chancroid**, also the result of the introduction of a poison, obtained in the same way as the preceding, but which never gives rise to syphilis. It is described elsewhere (see INDEX). It is painful, pours out abundant discharge, is accompanied by inflammation and swelling, but has not the hard gristle-like feeling of the true chancre. Moreover, matter from the soft sore, getting into a scratch on any other part *of the same person's body*, will reproduce a similar sore; while, on the other hand, matter from the true chancre cannot produce a second sore on the same person, though it can produce a sore like that it came from on another person. One or two weeks after the appearance of the *true* chancre, the glands in the groin become affected. In fig. 113 on page 208 is a representation of the glands in the groin. Those marked *d. e. f.* in the figure receive material from the genital organs, and if the poison of syphilis has been there introduced, it in time reaches the glands and affects them. They increase in size, not necessarily all of them, but several. The increase is slow and painless. On pressing with the finger, they are felt to be hard and are freely movable in their positions. They may become as large as almond shells, and so they remain for years, not coming to matter and giving rise to no trouble, but presenting almost conclusive evidence of the existence of syphilis. This is another distinguishing feature between hard and soft chancre, for the poison from a soft sore reaches the same glands, but causes in them inflammation and formation of matter, so that one or more buboes, as they are called, are produced, that is, abscesses, which are extremely stubborn and slow to heal.

And now there follow evidences that the poison has not only passed up from the spot, where it was introduced, into lymphatic glands, but has gained entrance to the blood, and

has affected the constitution. These evidences are called the **secondary symptoms** of syphilis, or briefly **secondaries.** The first of these is the appearance of a rash on the skin, which comes out in from six weeks to three months after infection, usually in about sixty or seventy days. The rash is at first of rosy red spots, which appear about the chest and belly, and may cover the whole body like a crop of measles. They soon become dull red or brown, and finally disappear, to be succeeded by pimples, which have a coppery colour. The pimples by and by fade, leaving copper-coloured stains in the skin, which take some time to disappear, but leave no scar. They begin on the trunk of the body, but spread to the arms and legs, and, unlike many ordinary skin affections, do not miss the palms of the hands and soles of the feet. They may come out in crops, off and on, for several months. Moreover, this rash of syphilis is capable of assuming many various forms; but, whatever the form, one great peculiarity is the coppery colour of the staining of the skin which attends it. The skin of the scalp is often affected, scales forming; and the hair loses its gloss, becomes dry, and tends to fall out, so that baldness may be produced.

Some amount of feverishness, loss of appetite, paleness, weakness, headache, and rheumatic like pains, often very severe, are not uncommonly experienced just before the appearance of the rash.

On page 307 it is explained that mucous membranes, the covering of red parts like the lips, inside of the mouth, throat, &c., are practically of the same structure as the skin. Hence it is not surprising that affections of the mucous membranes occur similar to those of the skin. The mouth and throat commonly suffer; the tonsils (p. 136) are liable to ulcerate, the nostrils and box of the windpipe sharing in the trouble. Raised patches about the corners of the mouth and anus (p. 130) are frequent.

Now it is certain that the matter that oozes from, or covers, these ulcers and raised patches, is capable of communicating the disease. This is a fact of the utmost importance to observe. What it implies is this, that a person who has such syphilitic ulcers or patches in throat or mouth, or tongue, is capable of communicating the disease by a kiss, if the slightest crack or fissure exists on the lip of the person kissed, by which the poison could enter. Moreover, for the same reason, a healthy person using without cleansing, cups, tumblers, &c., that have been just previously used by a syphilitic person may contract the disease. Thus while at the beginning of these paragraphs on syphilis it has been said that the disease is usually contracted by impure sexual intercourse, it is not uncommon to find it, in perfectly innocent persons, acquired by such other ways as have been indicated. For example, a hard chancre on the lip is often seen. A child who has inherited syphilis from its parents may communicate it to its wet nurse during suckling, and a wet nurse by the same means may communicate it to a child. Besides the affections of skin and mucous membranes, mentioned as secondary symptoms of the disease, others are common. Serious inflammations of the eye—inflammation of the iris and of the retina and optic nerve (p. 375)—are quite ordinary results. Affections of bones and joints, indicated by severe pains of a rheumatic character, usually worse at night, are also frequent. The bone affections are commonly marked by the appearance of small painful lumps, usually on the shin-bones, to which the term "nodes" is applied. In fact the diseases which may arise in the progress of the secondary stages of syphilis, due to the poison in the blood, are innumerable, and are only properly treated when their cause is recognized. This secondary stage lasts for from six to eighteen months, during which the general health of the patient is liable to serious disturbance and depression. At the end of that time the disease may disappear, even without treatment, and not again trouble the patient. Symptoms are, however, apt to show themselves now and again still indicative of the operation of the poison, such as the occurrence of skin diseases of various kinds, of ulcers, &c., which are obstinate, even refusing readily to yield to treatment.

Moreover, at a variable interval after the end of the secondary stage, what are called **tertiary symptoms** may reveal themselves. The chief evidence of the third stage is the formation of collections of inflammatory material in various parts of the body, in skin, mucous membranes, muscle, bone, liver, and other internal organs, brain, and spinal cord. These new growths are called **gummata.** These growths readily ulcerate and break down, causing destruction of the substance of the part in which they happen to be. They may disappear without ulceration, but still their disappearance is attended by destruction of the part in which they are lodged and consequent contraction of the part, shown by deep and permanent scars. In the skin the growths form flat elevated patches of a deep purplish-red colour, called

syphilitic tubercles. Such destructive growths may form in the gullet, leading to contraction and difficulty of swallowing, in the box of the windpipe, attacking the vocal cords (p. 262) and causing hoarseness and loss of voice, in the nostrils, producing destruction of the gristly parts, giving rise to offensive discharge (STINK-NOSE, p. 365), and ending in falling in of the bridge of the nose; and in many other parts may similar growths occur. Tumours may form in the brain, and may cause deafness, blindness, paralysis, and other symptoms dependent upon their position. Intense and persistent headaches continuing for weeks without intermission are extremely suspicious of syphilitic disease of the brain.

The consequence of such long-continued disease is a gradual but marked loss of general health and vigour, shown by sallowness of complexion and increasing thinness and loss of strength, so that the result of the disease is a miserable existence and a premature end.

Inherited Syphilis. A husband may, of course, infect his wife. Syphilis is a very common cause of abortion, occurring usually about the fifth or sixth month of pregnancy. One miscarriage after another may thus be occasioned, each succeeding one may be at a later period than the one before, till after several abortions a child is born alive. A child may be born with, already at birth, signs of the disease. It is shrivelled, puny, and unhealthy looking, and speedily dies. Commonly, however, at birth the child is healthy looking, and the signs of the disease do not appear till three or four weeks later. A syphilitic child has sores, chaps, and cracks at the corners of the mouth, ulcers of the mouth, and is afflicted with snuffles, owing to similar affections of the nostrils. Little soft growths are found about its anus (p. 130), and a rosy rash about the buttocks and neighbouring parts is a most common sign. It is peevish and fretful; its skin is dry and withered-looking, its face old and weird-looking, its hair scanty, its body thin and wasted. These symptoms, if the child live, disappear about the end of the first year, but scars are left to mark the seat of the sores. In later life the bridge of the nose is sunken, the teeth have a pegged appearance, and the clear part of the eye (cornea) is liable to suffer from an inflammation that makes it cloudy and of a ground-glass appearance.

A child may inherit syphilis from either parent; but a curious fact is that the child of a syphilitic father may exhibit the disease which the mother has escaped. The father may, that is to say, infect the child without previous infection of the mother.

Treatment.—It may be stated as a general rule that, if proper treatment be adopted early in the disease and persisted in, and *if the patient be a person of temperate habits, and, above all things, if he abstain from habits of drinking*, the disease may be got rid of within two years of infection. In regard to children it may also be said that, provided the disease does not appear for several weeks after birth, *and if the child be properly fed and in every way well cared* for, proper treatment will effect a cure.

The general treatment consists in good nourishing food, moderate exercise, moderation in, indeed abstinence from, all liquors, perfect cleanliness, and moderate exercise in the open air. Frequent washing of the whole body with soap and water, and an occasional Turkish bath are of importance. Flannel should be worn next the skin, and care to avoid chills taken. The patient should continue his work or business to give mental occupation. Smoking should be entirely given up if the mouth or throat is ulcerated, otherwise it should always be moderate.

As regards special treatment, a brief statement may be given of the treatment of an ordinary case in its different stages; but wherever possible the patient should place himself in the hands of a qualified physician, and should scrupulously follow his every direction. As regards the chancre, it is doubtful whether any treatment by burning, &c., will destroy the risk of the constitutional disease arising. The sore readily heals if cleanliness and frequent bathing are practised. If the patient is anxious to have it destroyed, caustic should not be used, but strong nitric acid. A brush, moistened with the acid, is lightly brushed over only the crack or ulcer, sound skin being avoided, and the sore is then bathed with cold water. A healthy sore remains, when the slough, due to the burning, separates. It soon heals if kept clean by bathing. Often the secondary symptoms appear before the patient is aware of having contracted the disease, the chancre having been unnoticed. When they appear, or to avoid them, if the chancre has been observed, the drug employed is mercury. Mercury has gained a bad reputation, because in former times it was improperly used. When properly used it is perfectly safe, and it is the only drug that can satisfactorily deal with the disease. When required when the secondary symptoms are slight, or used as a precaution, it may be given

in pill according to the following prescriptions:—

Blue Pill, 1 grain.
Extract of Gentian, 1 grain

to be made into one pill. One such pill is to be taken after meals thrice daily. It is well, before taking the first pill, to clear out the bowels by a double strong seidlitz-powder. If the mouth and gums become sore the pill is to be taken less frequently—twice daily, for example—or its use may be stopped for a day or two and then resumed after another purge. If treatment is not begun till the secondary symptoms have lasted for a time, such as sore throat, skin eruption, &c., the following mixture may be employed instead of the pills:—

Bichloride of Mercury, ...2 grains.
Chlorate of Potash, ...60 ,,
Water,..............................to 8 ounces.

Of the mixture a dessert-spoonful in water is taken thrice daily after meals.

If the above treatment by pills is adopted as a precaution only, it should not be stopped after several weeks because no symptoms have appeared. It should be continued for at least six months, and preferably twelve months, though not necessarily continuously. It may be stopped for a few days at a time and then resumed, and if after four or six months no symptoms have appeared, the dose may be reduced to two pills daily. Where the secondary symptoms have appeared the treatment *must not be dropped* simply because the rash on the skin has disappeared, the throat become well, and the health has apparently been restored. It ought to be persisted in for twelve months, and beyond that if symptoms still exist. If symptoms have ceased long before the twelve months have passed, the medicine may be stopped for short intervals and then resumed, and smaller or less frequent doses employed. Six months must pass, during which the person is free of symptoms, before the person can be pronounced cured.

In the third stage of the disease the drug used is iodide of potassium in 3-grain doses, dissolved in water and taken twice daily. It is well, in ordinary cases, after ceasing the use of mercury to use the iodide for several weeks. Iodide of potassium has a marked effect in the nervous troubles of the third stage. Thus for the continuous intense headache a dose of 10 grains may be given to begin with three times a day. The dose is daily increased by 3 or 4 grains till the person may be taking even 90 grains a-day, or till the headache ceases, when the dose is gradually brought down; but the smaller dose is to be persisted in for months. Sarsaparilla in dessert-spoonful doses may be given with the iodide. It helps the patient to bear the latter drug.

Great benefit is derived from a course of treatment at sulphur baths, such as Aix-la-Chapelle.

There are some people who cannot bear either mercury or the iodide, but it is impossible here to consider exceptional cases.

Ulcers and other sores may be bathed with a wash containing, to each ounce of water, 2 grains of sulphate of zinc.

For children a flannel bandage should be made to fit round the belly. On the surface next the skin a piece of mild blue ointment of the size of a pea should be smeared nightly. The movement of the flannel rubs it into the skin, which should be washed every third day. By the mouth syrup iodide of iron, a third of a teaspoonful, should be given thrice daily. Cleanliness and good milk are essential.

The extremely contagious nature of the disease has been pointed out. It is, therefore, scarcely necessary to say that a syphilitic person should abstain from sexual intercourse, from all contact, indeed, with others. It is probable, however, that in the third stage the contagiousness is not marked.

As regards marriage, it is almost a crime for a syphilitic person to marry before a year has elapsed without any sign of the disease. A person who has passed through the disease, and has been properly treated, should, therefore, not marry till three years have passed from the time of infection.

Cerebro-spinal Fever (*The Black Sickness* (popular name in Dublin)—*Spotted Fever*).—This is a fever which is probably contagious, and certainly occurs in an epidemic form. It is rare after forty years of age, and is not uncommon among young children. The symptoms are due to inflammation of the membranes of the brain (p. 91) and spinal marrow.

Symptoms.—The disease may begin with feverishness, headache, pains in the back and limbs, and feelings of illness lasting for a few hours or a couple of days before any serious disease is feared. Usually, however, the attack is sudden, coming on with collapse and insensibility or with severe shiverings (rigors), intense headache and dizziness, excessive pain in the back of the neck and along the spine, constant vomiting, pain in the stomach and cramping

of the muscles of the legs. The fever is not necessarily great, but the patient is restless and delirious or drowsy. The skin is over-sensitive, so that slight touches give rise to complaints of pain. One marked symptom is a stiffening of the muscles of the head and back, so that the patient's head and neck are arched back. A rash of blebs (*herpes*) appears on the lips. Purple spots (*petechiæ*) come out about the second day, in severe cases within the first twenty-four hours. They appear first on the legs. Purple blotches also appear over the body in very severe cases. Death may occur from collapse within a few hours of the attack, or from the first to the seventh day, the patient passing into stupor and from it to death. Death may not occur for several weeks, and may then be due to complications. Paralysis is a common complication and so also are affections of eyes, ears, and joints.

Even in favourable cases the illness lasts from two to six weeks, the extreme weakness that results being a cause of the delay.

Treatment.—If the attack begins with collapse, it must at first be met with the application of heat to the limbs and over the heart, and the administration of small quantities of stimulants. Mustard plasters over the chest and back are also recommended. When this stage is over, the intense pains in the head and back are relieved by ice bags on the back of the head and along the spine. For the same purpose opium given every two or three hours in 25-drop doses, as long as it appears safe, is recommended. *This must only be given to adults. Opium must never be given to children without express medical orders.* To them bromide of potassium in 5-grain doses every two hours may be advised.

Small quantities of strong beef-tea, and similar fluid nourishment, are to be given frequently.

At a later stage of the disease 3-grain doses of iodide of potassium may be given every four hours to aid in the removal of the inflammatory material poured out on the brain. To children the dose should begin at 1 grain.

The disease is extremely fatal, often within the first twenty-four hours owing to the nervous disturbance. Energetic treatment at the outset might relieve the brain, and therefore no delay should be permitted to occur in seeking skilled advice, wherever possible.

NON-INFECTIOUS FEVERS.

Ague (*Intermittent Fever—Marsh Fever—Malaria*).—Ague or intermittent fever is not a disease that may be communicated from one person to another. It is, nevertheless, a fever which is apparently due to the introduction of some poisonous agent into the body. The poison, called **malaria**, is bred in marshy places, where the energies of the soil are not used up owing to want of cultivation. Two conditions are apparently necessary for making a tract of land malarious: one is that for a season the land must be soaked with water which has no regular and sufficient outlet; and the second is that, following the period of soaking, a period of drying occurs, during which, under the influence of a hot sun, the land becomes dried up for some distance below the surface. It is during the latter period that the poison of malaria is produced, and that the region becomes unhealthy. Thus ague-districts are more common in countries where periods of drought regularly follow rainy seasons.

Drainage and cultivation are certain methods of ridding a district of malarious characters. In regions where ague and similar marsh fevers are common the poison rises from the ground with the vapours given off from the ground. In consequence, the poison is more abundant in the atmosphere nearer the ground, and is in diminished quantity in proportion to the height above the ground. So marked is this, that in ague-districts the upper stories of houses are more healthy than the ground-floors. The poisonous vapours may, however, be carried by air-currents up the sides of mountains in the immediate neighbourhood of the ague-districts, and by the same means may be conveyed to some distance beyond the place where they have been produced. The intervention of a considerable surface of water, such as that of a lake or river, will greatly prevent such conveyance; and a thick belt of trees has a similar effect.

One attack of ague, instead of protecting against a second, renders a person more liable to renewed attacks from the least exposure to the poison. Moreover, one who has suffered from ague is liable to other attacks even without being again exposed to the action of malaria.

Fever may appear in persons within a day or two after the reception of the poison, while others may have been removed for months from the malarious district before evidence of their having become affected by the poison presents itself.

Symptoms.—The feature that marks marsh fevers is that there are several attacks of fever separated from one another by intervals, during which the sufferer appears comparatively well. In its progress the fever has three well-marked

stages: the cold stage, the hot stage, and the sweating stage, following which is the period of the intermission, as it is called, in which the fever is completely absent. This period lasts for a variable time, and is succeeded by a second attack of the fever, going through the same stages as the first, ending in an intermission, followed by another attack, and so on. In one case the interval between the beginning of the first attack and the beginning of the second is only twenty-four hours. There is, in this case, a renewed attack of fever daily. This form is called **quotidian ague.** In another form, from the commencement of the first attack to that of the second is forty-eight hours. That is to say, there is a renewal of the fever every other day. This is called **tertian ague.** In a third form, the fever is renewed the third day from the beginning of the previous attack. This is **quartan ague.** In other cases the fever returns every fourth, fifth, or sixth day.

For some time before the disease actually attacks, the person may complain of weariedness, loss of appetite, headache, and pain in the back, or the disease may begin suddenly.

The *cold stage* is marked by a feeling of coldness; the person shivers; his teeth chatter and his limbs tremble violently; the face and hands are blue with the cold; and the skin is shrivelled and presents the appearance of "goose-skin." There is uneasiness about the stomach; headache and pains in back and limbs are present. Much very clear water is passed, and frequently. This stage may last from half an hour to several hours. The cold is only apparent, for if the temperature be taken with the thermometer (p. 10) it will be found already above the usual height.

The *hot stage* comes on gradually with the disappearance of the pinched and blue appearance of the skin. From feeling comfortably warm the patient becomes intensely hot, the face being flushed, skin dry and harsh, pulse full and frequent, and thirst being great. The person becomes restless, and sometimes slightly delirious. The headache is severe; and the sickness continues. This stage lasts from one to four or five hours, or even longer.

The *sweating stage* begins with the appearance of beads of perspiration on the face and brow. The hands and skin begin to get moist, and the person feels more comfortable. Soon copious sweating breaks out all over the body. The fever falls and the pulse becomes slower and softer. The breathing is less hurried than in the hot stage. Soon the fever is quite gone, and the patient comparatively well, but tired and inclined to sleep. The average length of the whole attack is from five to six hours, but it may be prolonged for double that time. In some cases one or other of the stages may not be well marked.

After a varying time a second attack comes on, as already noted, which goes through a similar course.

There is no definite time when the whole illness will pass away. But a person who has suffered from ague is always liable to renewed attacks on the slight provocation of a cold, indigestion, &c.

Persons who continue to reside in a malarious district, and who suffer from periodical attacks, gradually pass into a chronic state of ill-health, marked by a peculiar sallowness of complexion. Serious changes occur in the blood, liver, and spleen, producing a condition of poverty of blood and a tendency to dropsy, jaundice, and various other affections.

Treatment.—The treatment of ague is naturally twofold: that of the attack and that of the intermission. During the attack little can be done except in the way of making the patient as comfortable as possible. From the nature of the disease it is needless to attempt to arrest its progress. During the cold stage, therefore, the use of a plentiful supply of warm coverings, hot drinks, hot-water bottles, &c., will be grateful to the patient; and so, on the other hand, will be light coverings, a cool atmosphere, and tepid sponging of the body during the hot stage. It is during the period of absence of fever between two attacks that medicine must be administered to ward off, if possible, a new attack. The medicine to be given is quinine. Ten grains should be dissolved in water, to which a drop or two of tincture of steel have been added to aid the solution, and this dose given at the end of the sweating stage. It is to be repeated in four or six hours. After each renewed attack the quinine is to be administered in this way, and after the fever has ceased to return, the use of a daily dose of quinine must still be persisted in for a week or more. Nourishing foods should be administered, and to aid in the restoration of strength 30 drops of Easton's syrup (syrup of quinine, iron and strychnine) should be given in water thrice daily before food.

Whenever possible a person attacked by ague should be at once removed from the marshy district.

The prevention of ague is best accomplished by efficient draining and cultivation of the

district where it occurs by the clearing of jungle, and by similar means. The exercise of great care may enable one, compelled to live in a malarious district, to evade the disease. The person should sleep in the upper part of the house, should avoid going out late in the afternoon and early in the morning; all water should be filtered or boiled before use; excessive fatigue should be avoided; and quinine should be regularly taken.

Whenever a person, from repeated attacks of the fever, has become constitutionally affected, nothing should be allowed to prevent removal from the malarial situation to a healthy climate for a prolonged period.

Remittent Fever (*Bilious Remittent—Jungle Fever*) is a form of ague, but more severe in its symptoms and of a much more fatal tendency. It is due to the same cause as ague, and presents similar symptoms.

Symptoms.—The disease has its cold, its hot, and its sweating stage like ague. The cold stage is, however, very short, and hardly recognizable. The fever of the hot stage is very high, and this period is prolonged, lasting from six to twelve hours. The vomiting which occurs is violent and distressing. The material vomited up is first colourless, then bilious and sometimes bloody. The sweating stage is not so marked as in ague. With it the fever diminishes and the other symptoms improve, and the *remission* occurs, which differs from the interval of ague in the important fact that the disease does not disappear for a time as in ague, but simply abates to renew its violence in a short time—from ten to twelve hours. The remission usually occurs in the morning, and the fever is at its height at midnight. Day after day the attacks recur, usually at first with increasing severity. The illness lasts from five to fourteen days, and a favourable termination may be expected when the remissions are distinct and last for several hours.

Treatment is similar to that of ague. It is said to be well to begin with a purgative as soon as the disease manifests itself, and to an ordinarily strong adult 3 to 5 grains of calomel, the same of compound extract of colocynth and of powder of scammony, with 5 grains of quinine are advised. In the absence of these separate ingredients, one blue and one compound colocynth pill with 5 grains of quinine form about the same dose. No more medicine is to be given till the first remission, when 10-grain doses of quinine must be administered as advised for ague. If the person cannot retain the quinine on the stomach it should be carefully injected into the bowel (see ENEMA). To relieve the sickness, small pieces of ice should be given to suck, and warm cloths are applied over the stomach. When the fever remits, nourishing food is necessary, and if the exhaustion is great stimulants in repeated very small quantities. The other directions given under Ague apply equally to Remittent Fever.

Rheumatic Fever (*Acute Rheumatism*).—Acute rheumatism is a disease accompanied by very high fever, and attended by characteristic joint pains. The tendency to the disease runs markedly in families; and previous attacks increase the liability of a return. It affects mostly persons under the age of thirty. Exposure to colds, chills after overheating, &c., are frequent causes.

Symptoms.—The disease usually appears with signs of an ordinary attack of cold, such as a general feeling of illness, loss of appetite, sore throat, disturbed sleep, pains in the bones, feverishness, &c., the signs of what is commonly called an influenza cold, symptoms described under catarrh (p. 154). The chief signs of the fully formed disease are, high fever, pains in the joints, and severe sweats. The joints attacked are usually the larger ones, ankles, knees, wrists, shoulders, and elbows. The joints are not attacked all at once, but one after another as a rule, one joint getting well when another is becoming more painful. The pain is often excessive, so that the person lies straight and motionless in bed, afraid even of the slightest shake to the bed. The affected joints are hot, tinged with redness, tender to touch, and swollen. When the swelling has fallen, and the pain nearly gone, a feeling of stiffness remains. The muscles are also affected, and liable to painful twitchings. After the pain has begun in a joint, it increases till it is very severe, and then gradually dies away, the swelling disappearing with it. However much the joint may be swollen, matter is practically never formed in it. During the illness the whole body is bathed in sweat, which has a peculiar sour smell, easily perceived by everyone who comes near the patient. The sweats continue throughout the disease, and gradually pass off with recovery. The fever is often so high as itself to threaten life. In addition to these symptoms the tongue is white, appetite bad, bowels irregular, and pulse fast (120 per minute).

While these are the usual signs of a regular

attack, the disease may occur in a much milder form, with slight fever lasting only a day or two, only one or two joints being affected. In many such cases the disease frequently returns.

The length of the illness is never very definite, varying from two to six weeks or longer, but when the patient is properly attended to the severe symptoms should not last much beyond nine days. Recovery of strength is, however, slow. Death from the rheumatism itself is not common. But in the train of rheumatism are a great many other diseases, especially heart disease (namely, valve disease of the heart (p. 339), and inflammation of the pericardium (p. 238)), inflammation of the lungs and air tubes, and various others. Indeed the great risk is that of affection of the heart.

Treatment.—The patient should be in an open bed lying between blankets. The affected joints should be kept at rest. An aid to this is obtained by wrapping them in cotton wool, secured by a flannel bandage. The principal medicine now given is salicine or salicylate of soda. It is administered in 20-grain doses in water every two hours for twelve hours or so, when the pains are generally relieved and the fever falls. Thereafter the powders are repeated every three or four hours or at longer intervals. The evil of the remedy is that it frequently produces deafness and unpleasant noises in the ears, and sometimes sickness and faintness. In spite of the noises in the ears, &c., the powders should be persisted in if necessary, as the unpleasant symptoms attending their use will pass away in a few days. But if sickness or faintness arise a more sparing use of them must be made. It is marvellous how quickly in many cases this treatment relieves. When it does so, the dose should be continued twice or thrice daily for several days after the fever has passed away. Then a quinine and iron tonic should be given, and great care must be taken for some time to prevent a relapse. Sometimes this treatment fails. In such a case the old treatment with potash must be resorted to. Thirty grains of acetate of potash are to be given every 3 or 4 hours. At bed-time 10 grains (*to an adult*) of Dover's powder will relieve pain and help sleep. Quinine and iron tonics are also necessary after the fever has passed. Throughout the illness nourishing, easily digested foods are to be given *in small quantities* frequently repeated. Milk and milk puddings, thin mutton broth, &c., are best, but no butcher meat should be allowed till recovery has taken place. Soda water and milk is a grateful drink to the patient. The bowels also require attention, an ordinary purgative medicine being given as required.

Though the treatment has thus been mentioned in some detail, it is needful to say that no case ought to be without medical supervision, unless that is absolutely unavoidable. A physician will often detect commencing affection of the heart, and take steps to prevent it if possible. Neglected cases too often end fatally in time because this evil has not been guarded against.

Chronic Rheumatism, as it affects the joints, is discussed on p. 33.

Section XIV.—SOME GENERAL DISEASES.

TUBERCULOSIS AND SCROFULA. GOUT. CANCER. DROPSY.

TUBERCULOSIS AND SCROFULA.

Tuberculosis is the term applied to a general disease, due to the formation of tubercles in various organs of the body. The nature of tubercles has been shortly explained on p. 165, and at greater length on p. 278, but to give a complete idea of the disease, the chief points of these explanations may be again mentioned. A **tubercle** is a little nodule, grey in colour, about the size of a millet seed, consisting of a collection of round cells. It is to be considered as a new growth, foreign to the part in which it is present. The little nodule tends to increase in size by the growth of others round it. By its growth it destroys the substance of the part in which it is placed, occasioning also inflammation in the surrounding parts. It has no great vitality, and undergoes changes, which begin in the centre of the nodule, the result of which is to convert the firm grey mass into yellow cheesy material. The process may go on till the nodule becomes quite broken down into soft matter, and, if the matter can break out from the part, an ulcer is left. Instead of softening, the nodule may become hard by the

deposit of lime salts in it, and become converted into a little solid mass in the substance of the tissue where it is lodged.

Now the effects produced by the formation of such tubercles depend on the organ or tissue of the body in which the diseased process is going on. In the general disease tuberculosis the formation of the grey nodules proceeds in most of the organs of the body—lungs, liver, kidneys, lymphatic glands, bowels, membranes of the brain, &c., and the symptoms produced are those of a fever, and strongly resemble symptoms of typhoid fever. This form of the disease may last two or three weeks, and its termination is death. The true nature of the disease it is extremely difficult to recognize during life.

On the other hand the formation of tubercles may be limited to one organ of the body, at least at first. Thus if the formation is principally in the lungs, it produces consumption (p. 277). In the bowels it produces consumption of the bowels (p. 105). The same process going on in the membranes of the brain is the cause of acute water-in-the-head (p. 101); and a similar tubercular deposit in lymphatic glands is believed to be the cause of the swelling and breaking down of the glands that are the main features of scrofula.

Recent investigations have tended to establish a relationship between the growth of tubercle and the activity of some peculiar form of germ. That tubercle spreads by contagion is evident. In cases of tuberculous consumption the throat is commonly affected by tubercular ulceration, so that the voice is hoarse and may be lost; and this is due to the contact of the spit from the lungs. Moreover, in such cases tubercular ulcers are usually found in the bowels, probably because the contagious matter is swallowed and the ulceration thereby extended. But definite experiments have conclusively proved the truth of the contagious character of the disease (refer to p. 393).

The tendency to tubercle is hereditary. No age is free from the possibility of an attack; but it is most common in early life.

It is needless to discuss the symptoms or treatment of the general disease, and the special affections of lungs, bowels, and brain have been considered elsewhere. Where the tendency to this form of disease is known to exist in families, much may be done to avoid its appearance. The general treatment is the same as that suggested for scrofula, which, as has been already indicated, is a manifestation of the tubercular taint.

Scrofula (*Struma—King's Evil*) is a constitutional condition in which the general health is much weakened, and in which there is a great tendency to slow inflammation of various parts of the body and to the formation of abscesses and ulcers slow to heal. (The disease was called King's Evil from the idea that it could be cured by the king's touch.) It is a condition occurring in families and descending from parents to children. The organs of the body specially apt to suffer are the lymphatic glands, which become enlarged, softened, and readily break down, becoming converted into cheesy material. When it is the glands about the neck (p. 208) that are specially affected, the disease is evident, but other glands deep-seated and not within reach of examination are equally prone to the affection, which may, therefore, not be so evident. Scrofulous persons are often in early life of a pasty complexion, pale and flabby, with sluggish circulation, stunted in growth, with short narrow chest, and prominent belly, and soft muscles. Others again are of bright fair complexion, with light red hair, and are unusually bright and clever. Many children, though apparently scrofulous, gradually grow out of this condition and become vigorous men and women.

While inflammation and formation of matter in the glands are the popularly known signs of the scrofulous condition, many other organs of the body may be the seat of scrofulous disease. Thus some kinds of inflammation of the eyes are essentially scrofulous; scrofulous diseases of bone and joints are common; chronic eruptions and ulcers of the skin, discharges from the ear and nose, are also frequently the result of the bad condition of health. Consumption of the lungs or bowels may arise from the same general weakness.

Scrofula is believed to be a manifestation of tubercle, discussed above, and the breaking down and suppuration of glands, the distinctive feature of scrofula, to be the result of the deposit within the glands of tuberculous matter.

Treatment.—Nothing so much aids in the progress of a scrofulous tendency than bad food, bad air, want of cleanliness, and the absence of opportunities of healthy exercise, and nothing is so effective in removing the disposition to the disease than the removal of these evils. A scrofulous child should be regularly bathed; it should be clothed in flannel. Plenty of fresh air and sunlight are absolutely necessary. Nothing is, consequently, so valuable as a change from a close town to the sea-coast. Moderate sea-bathing is very useful. If this cannot be ob-

tained, the child should be bathed at home daily in a bath containing Tidman's sea-salt, and should be vigorously rubbed afterwards. Food is to be liberally allowed, especially sweet milk, eggs, soups, &c. Cod-liver oil is the chief medicine, and should be given for a long period, indeed long after health appears quite re-established. Most children learn to like it. Small doses should be given at first, half a tea-spoonful twice daily, and the dose should be gradually increased till a dessert-spoonful or a table-spoonful is being taken thrice daily. To those who, after patient trial, cannot get over the taste of the oil, malt extract or malt extract and cod-liver oil may be given. Another valuable medicine is iron, given as dialysed iron (4 to 10 drops (according to age) five times daily in water), or as syrup iodide of iron (a half to one tea-spoonful thrice daily), or as Parrish's syrup of the phosphates, commonly called chemical food, given in a half to one or two tea-spoonfuls thrice a day. The cod-liver oil and the iron tonic may be given at the same time.

Glands that have become swollen and painful ought not to be rubbed, nor irritated in any way (see p. 209). The oil and the syrup of iodide of iron ought to be persevered with, and the neck simply protected by a strip of flannel. Frequently the affected glands will recover under this treatment if not worried into suppuration. If, however, matter forms in the glands, the sooner a surgeon opens them the better.

GOUT.

Gout is a markedly hereditary disease, descending from parents to children in a very remarkable way. Men are more frequently attacked than women; the age most liable to the disease is between thirty and forty-five. The circumstances that usually determine an attack in those liable by inheritance to the disease, or that excite the disease for the first time, are habitual excess in eating, specially in the over-eating of animal food and rich dishes, long-continued excess in drinking, especially strong wines, such as port, sherry, madeira, and malt liquors (beer and porter), and prolonged want of proper exercise. It appears also that persons subject in their occupation to the influence of lead are rendered more liable to an attack, if other circumstances favour it. It appears that the disease is due to an excess in the blood of a substance called uric acid, either because it is formed in the body in too large quantity, or because it is not removed from the blood by the kidneys in the urine as it ought to be. It is a disease specially apt to return frequently, very slight causes being sufficient to determine an attack in those subject to it. Thus even a slight degree of indigestion, irregularity of bowels, cold, mental anxiety or worry or excitement may occasion a fit of the gout in gouty persons.

Symptoms.—An acute attack of gout usually comes on suddenly during the night with pain and swelling in a joint, commonly the joint that forms the ball of the great toe. The joint becomes not only much swollen, but also turns red and shiny, the veins on the foot and part of the leg being very marked. The pain is often extremely severe, and is burning or shooting in character. Other joints may also be attacked, the smaller ones specially. The least movement is almost unbearable, and even the weight of the bed-clothes is not endurable. Towards morning the pain lessens, but next evening it returns, and this may continue for a week or ten days, when the severe symptoms pass away, though the joint remains swollen and tender for some time longer. However swollen the joint may be, matter does not form. Attending the joint affection there are general symptoms of disturbed health, shiverings and sweatings, loss of appetite, white tongue, increased heat of skin, quick pulse, confined bowels, and scanty high-coloured urine, from which a brick-red deposit separates out on cooling. The sleep is much disturbed; cramps and startings of the muscles of the leg are common; and the patient is of very irritable temper. After the first attack the joint apparently quite recovers. As a rule the disease returns sooner or later, generally within a year; and not only does it tend to return, but the intervals between each "fit" become shorter. With the greater frequency of attack, more joints are liable to suffer—joints of foot, hand, ankle, knee, &c. As the disease becomes chronic the joints become permanently altered. They enlarge, and deformities are produced, due largely to the deposit within the tissues of the joint of masses of urate of soda, called "chalk-stones," which not only form prominences and irregularities, but by being deposited around the joint tend to fix it in unusual and awkward positions. Abscesses may form round the chalk-stones, from which they may be discharged, leaving ulcers. The general system tends to become affected and the person to grow feeble and weak.

Those who suffer from attacks of gout are often warned of an on-coming "fit" by symptoms not well marked, but which, by experience, they know too well the meaning of. Those

symptoms may be connected with the digestive organs—flatulence, heartburn, irregularity of bowels, or connected with the heart, such as palpitation; or there may be headache, irritable temper, and various other nervous symptoms.

There are forms of **irregular gout** that show themselves by severe stomach disturbance, such as acute spasmodic pain or cramp and bilious vomiting, or by disturbance of the heart, evidenced by palpitation, faintness, &c. By similar attacks of irregular gout the breathing may be much disturbed and rendered so laborious that suffocation seems to threaten. Nervous and other symptoms may also be due to a similar cause.

Treatment.—Very strict regulation of the habits of life is one of the most important elements in the treatment of gout. The person must exercise great restraint in eating, and must take no more than is necessary for proper nourishment. A mixed animal and vegetable diet is the best, but the amount of animal food in particular must not be in excess. Of this class of food the best kinds are white fish, game, fowl, and mutton. Fat meat such as pork, salted and spiced meats, and all rich dishes are to be avoided. In regard to vegetables, some believe in the free use of celery. Stewed fruits are allowed, but no pastries, and the fruits should be sparingly sweetened. Extreme moderation in drink is absolutely necessary, beer, porter, and rich wines, champagne included, being rigidly abstained from. Such wines as hock, moselle, claret, alone are safe; whether they should be used at all, and, still more, whether any whisky or brandy may be taken, ought to be left to the decision of a medical attendant. Water should be the principal drink. Tea and coffee are not necessarily harmful. Potash, soda, and lithia water, may do much good, and ought to be taken freely, but only between meals.

The gouty person should take regular outdoor exercise daily, and should go early to bed and rise early. The clothing should be warm. Baths are of great use, and specially a well-ordered Turkish bath. Exposure is to be avoided; and sudden changes of temperature are to be guarded against. For this reason, where a choice can be made, an equable climate is to be preferred. As regards treatment during an acute attack, it should be begun with opening medicine, such as rhubarb (10 grains) and bicarbonate of soda (15 grains), the dose being repeated as found necessary. To relieve the pain the drug most extensively used is meadow-saffron or colchicum. The preparation used is the wine, given in water in 10 to 30 drop doses every four or six hours along with 6-grain doses of citrate or carbonate of lithia or potash. The use of the colchicum may be continued for several days if it agrees with the patient. At the same time the action of the skin and kidneys is to be promoted by the patient being kept warm, and drinking freely of barley-water, soda-water, or cream-of-tartar water flavoured with lemons. The food should be light and nourishing—milk and bread, a little beef-tea, &c.—and rather spare in quantity. The affected joint should be kept at rest, supported in a raised position, and surrounded by a piece of flannel dipped in warm water, and covered by cotton wool.

In chronic cases 3 to 6 grains of carbonate of lithia should be taken twice daily in a wine-glassful of water, and Carlsbad or Vichy water largely used.

CANCER.

Cancer (Latin *cancer*, a crab—*Carcinoma*).—The name of this disease is derived from the appearance of the part attacked by the disease, as it struck the ancients, the veins surrounding the diseased part resembling a crab's claw.

Cancer is considered in this section more as a matter of convenience. It is still a question much discussed whether cancer ought to be counted a local or a constitutional disease, and many reasons can be adduced for answering the question either way. It is certain, however, that after cancer has appeared in any part, however small and limited its position may be, and however insignificant it may appear, it will in time spread along various channels and affect the whole system.

Nature.—Its character is that of a tumour, swelling, growth, or deposit, which tends to spread, not simply by becoming larger and squeezing aside the healthy substance of the part in which it is placed to make room for itself, but by growing into the healthy parts, invading them, and incorporating them into itself. It can never, therefore, be removed from its position as a whole without other parts being disturbed, but if removed the whole mass of tissue in which it is placed must be cut out with it. Moreover, even if removed, it tends sooner or later to return, perhaps just because it so invades the tissues that it is impossible to make sure that all of it has been removed. This feature of it is one of the chief reasons why it is called "malignant." For it is evident that a tumour, whose tendency is always to return to the attack, is likely some day to overcome its

victim. A "simple" tumour, however, is one which, once removed, is done with. Not only does cancer tend to spread by direct invasion of the substance of the part where it is placed, but it also tends to spread to distant parts by conveyance along vessels. Blood-vessels are doubtless channels along which particles of cancerous material may be carried to parts at some distance from the original growth, and which, taking root in the new situation, proceed to grow and form a secondary tumour. Other channels, which afford an even readier means of transit, are the lymphatic vessels, which, as has been noted on page 200, are found in every tissue of the body as drains for the removal of excessive nourishment supplied to the part, and also for the removal of waste products. Into these channels, therefore, juice and particles from the tumour will find their way. The lymphatic vessels pass to lymphatic glands in order that the material they carry may be worked up into a fit state for return to the blood. Thus it is that some time after a cancerous tumour has appeared in some part of the body the glands in the neighbourhood are almost certain to be found enlarged and otherwise affected. It is this that renders it so difficult to remove a cancerous growth with any certainty of permanent cure. For the cancerous material may have been carried considerable distances from the original tumour by such channels, without any signs of the transference being evident for a long time. It is this also that renders it imperative that a cancerous growth should be remorselessly cut out as soon as it is discovered, and the smaller and more insignificant the growth appears the more eager should the patient be for its removal. But it is just at this stage of its growth that patients are indisposed to permit an operation. It is so small, or it gives so little perhaps no trouble, what is the need of operating at present? Wait till it is bigger, painful, troublesome, then the patient will consent. It is necessary earnestly to insist on the undoubted fact, the reasons for which have just been given, that it is while the growth is small and trifling that its removal is most hopeful, and that waiting till it is bigger means practically waiting till it is hopeless.

As to the nature of the growth itself, cancer is essentially formed of a degenerate kind of cell, and is originally connected with structures mainly of the epithelial type (see p. 16). Thus the surface layer of the skin consists of epithelial cells (p. 307), the mucous membrane of the mouth has a similar superficial layer (p. 136); the stomach and whole length of the intestinal canal (p. 140) has an outermost layer of cells; the membrane covering the windpipe and tubes of the lungs, as well as the air spaces of the lungs themselves, are covered with epithelial cells (p. 252); the kidney and bladder have similar inner coatings (pp. 290, 293), while glands, the salivary glands (p. 137), the glands of the stomach and intestine (p. 139), are also lined with epithelial cells. Now it is in these situations and others of a similar character that cancer is found, the cells coming under some degenerative influence, which causes them to multiply in enormous numbers and thus to invade the surrounding tissues and form deposits. The cells are held together by a small amount of connective tissue (p. 16), in whose spaces the cells lie. A cancer tumour is thus a growth formed of masses of cells in groups held together by connective tissue, the cells being originally derived from the natural cells of the part.

Varieties of cancer depend mainly upon the relative proportions of the cells and binding tissue, and of a fluid—the cancer juice—also present in the growth. Thus **hard cancer** or **scirrhus** has the binding tissue in greatest abundance, and forms a very hard tumour; **soft cancer, encephaloid** or **medullary cancer** contains more cells and is of a very soft consistence, growing also with greater rapidity than the hard variety; while **epithelioma**, or skin cancer, consists mainly of flat cells like those of the skin, or cells similar to those of glands, and occurs in the shape of an irregular ulcer.

Seat.—The position of the tumour may vary as already indicated. It may occur on the skin or on mucous membranes, like that of the tongue, lips, stomach, and other parts of the alimentary canal, in the bladder and womb, in glands, such as the salivary glands and breast, the glands of the intestinal tract, the liver, the testicle, the lungs, the eye, bone, lymphatic glands, nose, and many other parts. In fact it may occur almost anywhere. For even though it may originate only in epithelial structures, as already noted, it is easily transmitted to other parts, in which it could not begin, by the channels of the blood-vessels and lymphatics. In men a common seat of cancer is the lip, where it is of the epithelioma variety. In women the breast and womb are frequent situations, hard cancer being most frequently in the breast. Internally the stomach, liver, and lungs are common situations.

The **causes** of cancer it is not easy definitely

to state. Undoubtedly hereditary influence is great in many cases. Age has something to do with liability to the disease. The greater proportion of cases in men occur between fifty-five and sixty years of age, and in women between forty-five and fifty-five. It is twice as common in women as in men; and the liability seems to be greater in women who have borne children. These are of the nature of predisposing causes (see p. 4). Sometimes the occurrence of the growth seems to be determined in position by the presence of some long-continued irritation. Thus the irritation of a short juicy pipe, constantly smoked, has determined the appearance on the lip, and the irritation of a ragged tooth on the tongue, while cancer of the breast in a woman has followed at no distant time a blow on the breast. Frequently, of course, no such local cause can be suggested. It may be that with a constitutional tendency to the disease, it only required such an irritation to determine its occurrence.

The **progress** of the disease is slow or rapid according to the variety of the growth and its site, soft cancer being rapid in growth, epithelioma very slow. In its course the tumour continues growing for a certain time, and then it begins to break down, an irregular ulcer being formed from which a fœtid discharge proceeds. In time, sooner or later as the disease spreads quickly or slowly, and according to the speed with which it extends to other organs, the health suffers, and a constitutional state arises to which the term "cancerous cachexia" has been applied. The countenance is peculiarly pale and sallow, and the sufferer wears a very anxious and careworn look. The general surface of the body acquires a yellowish hue, the appetite is diminished, the strength gradually fails, and the pulse is weak. The patient complains of lassitude and of inability for exertion. Emaciation sets in, at last death ensues from exhaustion, or the combined effects of discharge, debility, and pain. Life may, however, be shortened more speedily owing to the interference of the tumour with the functions of some important organ, or to frequent attacks of bleeding from the ulcerating surface, caused by the disease opening into blood-vessels.

Symptoms of cancer it is impossible to discuss in detail. Those of cancer of the breast and the womb will be considered in the section on Diseases of Women. As regards internal cancer, its presence requires for detection a skilful and experienced physician. Concerning cancer of the lip and tongue it is only necessary to say that the presence of a ragged ulcer, with hard base, from which a foul discharge proceeds, and which refuses to heal, is suspicious, and ought to cause the sufferer to seek early and skilled advice.

Treatment.—No drug will cure cancer. The virtues of one medicine after another have been lauded in vain. Time and more experience have shown the worthlessness of them all. The only treatment for cancer is removal, if that is possible. Caustics have been used to burn out the mass, and are occasionally used still, but removal by the knife is the preferable operation. This a surgeon will not undertake unless with a prospect of being able to remove the whole growth. It must, therefore, be done early, before the disease has invaded lymphatic glands and other organs. When it is too late to operate, the only treatment is one to relieve the symptoms, to support the strength of the patient and to alleviate pain. Each case must, however, be treated on its merits, and requires medical supervision.

DROPSY.

Dropsy is an accumulation of fluid which has oozed out from the blood-vessels in the minute spaces in the tissue, or in some of the cavities of the body, the cavity of the belly for example. It is called by other names according to the position of the accumulated fluid. Dropsy confined to the tissue under the skin, in the foot, leg, or arm, for example, is called **œdema** or **anasarca**. Dropsy of the belly is **ascites** (p. 191). The accumulation of fluid round the lung in pleurisy (p. 266) is a dropsy, and a similar collection round the heart is called **hydropericardium** or dropsy of the heart (p. 238). On p. 203 it is explained that fluid is constantly oozing from the finest blood-vessels into the tissues to nourish them, that more fluid oozes than is necessary, and that the excess is picked up mainly by lymphatic vessels, and afterwards returned to the blood. Now suppose more fluid escapes than can be picked up by the lymphatics, or suppose the absorbing vessels are somehow prevented fulfilling their purpose, the excess of fluid will remain and accumulate in the tissues, and in a short time that part will be the seat of dropsy.

Causes of dropsy are thus readily understood. The quality of the blood may be so altered that fluid passes out very readily and in great excess. This happens in anæmia (p. 234), and in Bright's disease of the kidney (p. 295).

Again where obstruction exists to the return of blood to the heart, the blood accumulates in the veins; there is greater pressure on the blood, causing more to pass out of the vessels, and preventing also its absorption, and so dropsy again results. This obstruction may be merely local. A tumour pressing upon the main vein of a limb will thus produce dropsy limited to that limb. In pregnant women the pressure of the enlarging womb on the veins frequently causes swelling of the legs. Dropsy may be more general. Thus in certain diseases of the liver the circulation is obstructed, and since all the blood from the belly and the lower limbs passes through the liver the obstruction is experienced in all these parts and dropsy of both legs and of the cavity of the belly will soon ensue. A more general cause even than this, and more common, is heart disease, where the onward movement of the blood is hindered by some valve affection (p. 239) causing accumulation of blood in the veins of lungs, liver, and other parts, and occasioning extensive dropsy. In such cases the parts at the greatest distance from the heart, and in the lowest situations, will feel the pressure of blood most, and will show the evidence of dropsical swelling soonest and most markedly, for example the feet and legs. The same condition may be produced even when no real affection of the valves exists, if the heart is so feeble that it does not contract with sufficient vigour to cause a steady and regular circulation of the blood. The walls of the heart, yielding too much to the pressure of blood within them, may stretch unduly, and thus the heart becomes dilated and thin-walled in proportion to the degree of stretching. Under these circumstances the circulation is sluggish, and in time the blood in the veins experiences a backward pressure, which causes an undue amount of fluid to pass out into the tissues, and dropsy ensues. In these circumstances the swelling appears first in the feet and legs. It must not, however, be thought that swelling of the feet and legs is in every case caused by something wrong with the heart. Many people are troubled with swelling of the feet and lower parts of the legs after standing long or going about a good deal, the swelling usually disappearing after a rest in bed. This does not necessarily imply any particular disease. When a person stands, the weight of the column of blood in the veins of the legs is considerable, and if the vessels be relaxed in any degree the vessels widen unduly, and the movement of blood is slower than usual, allowing a greater oozing of fluid than can be quickly removed.

In pleurisy, dropsy of the heart, and similar instances, the accumulation of fluid is due not to obstruction to the return of fluid, but to an active determination of a much greater than ordinary quantity of blood by the acute inflammation going on.

The **treatment** of dropsy depends on the cause. The cause should if possible be removed; the state of the liver should be corrected if possible, the weak heart strengthened, &c. Drugs are employed for the purpose of removing from the blood and casting out of the body a larger amount of water than usual, and so encouraging the picking up of the dropsical fluid into the current of the circulation. Active purgatives, which cause large evacuations of watery stools, do this, such as jalap and elaterium. Other drugs effect the same thing by promoting an increased flow of urine, such as nitre, gin, spirits of juniper, and digitalis. Profuse sweating by means of hot-air baths aids in a similar way. Digitalis is a very useful drug, since it both strengthens the heart and promotes the action of the kidney. It is in cases where the dropsy is due to some condition of the heart that digitalis proves most valuable. By its strengthening action on the heart it causes more vigorous contractions and tends to restore efficiency to the circulation. But the employment of these means is always attended with risk, unless used by those who really understand the cause of the dropsy and adapt the remedy with care to the circumstances of the case. Therefore the treatment needs determination by a physician.

When treatment by drugs fails the accumulated fluid is frequently drained off by tapping.

Section XV.—THE MANAGEMENT OF CHILDREN IN HEALTH AND DISEASE.

The Management of Children in Health.

The High Mortality of Children and its Causes:

The Management of the Newly-born Child:

Food—Its nature—Frequency of supply—Choice of a wet-nurse—Rearing by hand;
Bathing and *Clothing;*
Exercise, Air, and *Sleep;*
Use of Medicines;
Premature Children;
Vaccination.

The Management of Children between the Sixth Month and Second Year:

Food—Weaning;
Teething—Milk-teeth and permanent teeth—Their periods of cutting;
Bathing, Clothing, and *Exercise;*
Children's Apartments.

The Management of Children in Disease.

General Signs of Disease in Children:

General Treatment of Children in Disease:

Affections of the Newly-born Child:

Irregularities of Form—Tumours of head and back—Harelip and Cleft-palate—Blue Disease, &c.;
Diseases of Navel and Eyes; Jaundice of the Newly-born;
Swelling of the Breasts.

Diseases Common to Childhood:

Ailments at the Periods of Teething and Weaning;
Coughs, Colds, and Affections of the Chest—Cold—Bronchitis—Cough;
Affections of the Mouth, Stomach, Bowels, &c.—Thrush (Sprue)—Inflammation and ulcers of the mouth—Vomiting—Colic—Looseness of bowels—Infantile cholera—Intussusception—Costiveness—Worms—Falling of the bowel—Rupture—Bed-wetting;
Spasmodic Diseases—Convulsions—Night-terrors—Child-crowing—Water-in-the-head, &c.;
Fevers;
Scrofula and Consumption—The treatment of delicate children;
Skin Diseases—Tooth-rash—Red-gum—Scalled head—Running ears;
Rickets;
Accidents—Burns, Wounds, Sprains, &c.—Falls on the head—Bleeding at the nose—Choking.

THE MANAGEMENT OF CHILDREN IN HEALTH.

HIGH MORTALITY OF CHILDREN.

That there is need for spreading broadcast fuller knowledge than the public evidently at present possesses of the proper methods of dealing with children, both in health and in illness, is strikingly evident from the statistics carefully collected and detailed by the late Dr. Wm. Farr, of the Registrar-General's Office. The facts are so clearly given in Dr. Farr's own words in his annual reports that a few extracts will best show what they are.

"In England and Wales the deaths of 2,374,379 infants in the first year of age were registered in the 26 years 1838–63; and of the number 1,329,287 were boys, 1,045,092 were girls."

"Nearly 100,000 infants die annually, in the proportion of about 56 boys to 44 girls."

"Even in the healthy districts of the country, out of 1,000,000 born, 175,410 children die in the first five years of life; but in Liverpool district, which serves to represent the most unfavourable sanitary conditions, out of the same number born, 460,370, *nearly half the number born*, die in the five years following their birth."

That is to say, one in every six children born dies within the first five years of life, even in the healthy parts of the country, but in the unhealthy parts the proportion is one-half. Moreover, Dr. Farr showed that the majority of the deaths occurred *within the first year of life*. Thus "of 100 children born, 15 die in the first year, 5 in the second, 3 in the third year, 2 in the fourth, and 1 in the fifth; making 26 in the 5 years of age. Of the 15 who die in the first year, 5 die in the first month of life, 2 in the second, and 1 in the third."

Now what is the cause, or what are the causes of such a tremendous infant mortality? That question also Dr. Farr tries to answer. The

result is given in tabular form. In the three years 1873–75 the annual number of deaths, from all causes, of children under one year of age to every 1000 births was 278. The separate causes of these 278 are given in the table:—

Total number of deaths to every 1000 births,		278
Of which the number of deaths caused		
by premature birth and atrophy (wasting) was		70
,, lung diseases	,,	51
,, convulsions	,,	31
,, diarrhœa (looseness of bowels)	,,	24
,, tubercular disease	,,	21
,, whooping-cough	,,	12
,, teething	,,	6
,, measles	,,	4
,, scarlet fever	,,	3
		222

The causes of the remainder are not detailed.

Of the 278, no less than 125 were due to such diseases as atrophy (wasting), convulsions, and diarrhœa. Commenting on the table Dr. Farr says: "Some of the principal causes are improper and insufficient food, bad management, use of opiates, neglect, early marriages, and debility of mothers; but whatever may be the special agencies at work which are so prejudicial to infant life, it must be borne in mind that a high death-rate is in a great measure also due to bad sanitary arrangements." "*The causes of death which are more directly the result of neglect and mismanagement are convulsions, diarrhœa, and atrophy*," and again, "the causes most fatal to infant life in factory towns, and which are inseparable from bad nursing and feeding, are diarrhœa, convulsions, and atrophy."

It is to be observed that in this table the number of victims of measles and scarlet fever is small, but it is in the second, third, and fourth years of life that these diseases are worst, and not during the first year to which the table is limited. It seems that since 1875 a considerable decrease has taken place in the average English death-rate, a decrease affecting not only the adult portion of the population, but the infant portion as well. It seems plain that this improved state of affairs is due to the operation of acts of parliament referring to public health, to the greater care consequently taken to keep down and rectify, as far as possible, unhealthy conditions, to more vigorous measures in dealing with and preventing the spread of infectious diseases, and to other similar causes. But public health acts touch very little those great causes of infant mortality, noted by Farr, "neglect and mismanagement," which are still the chief causes of an unnecessarily high rate of infant death. These causes are not limited to particular classes of society, though they may be more strikingly evident in one class than in another. Mismanagement of children is certainly very common in every grade of society, and is as frequent a cause of childish ailments in the houses of the rich as in those of the poor. The first part of this section is, therefore, devoted to a consideration of the proper methods of managing children in health.

THE MANAGEMENT OF THE NEWLY-BORN CHILD.

Food.—From the day of its birth till it is four or six months of age the child should be nourished, in ordinary circumstances, *entirely* by its mother's milk, and during that period no other food of any kind whatever ought to be allowed. It is a mother's chief duty in relation to her child to suckle it, and neither her pleasure nor convenience should, for a moment, be allowed to come into consideration. A bad state of the mother's health may make it advisable, not for her own sake only but also for her child's, that the child should be otherwise reared, but this is the only valid reason as a rule.

It often happens that there is no milk in the mother's breasts for some hours after the birth of the child, and it is the custom of most nurses in the meantime to feed it with spoonfuls of sweetened water. This is entirely a wrong and unnecessary proceeding. There are few children that cannot afford to wait for twelve or even twenty-four hours. The proceeding is also hurtful, leading to irritation of the child's stomach, and the production of wind, colic, and other evils. In every case the child should be put to the mother's breast, immediately after it has been washed and dressed, if the mother is not too tired, and at latest within an hour or two after birth. It often needs the exercise of some little patience before the child obtains a proper hold of the nipple. It should be aided by the nipple being drawn out with the fingers and moistened with milk. If there is milk in the breast the child will obtain satisfaction, and will soon relax its hold and drop off to sleep. The nipple should be removed from its mouth and dried to prevent hacking. But if no milk has been in the breasts, some advantage is yet gained in the drawing out of the nipple, and in the stimulus which has been given to the gland to hasten its activity. Between two and a half and three hours after the last suckling the child must again be put to the breast, and this is the

proper interval between each period of suckling for the first ten days or a fortnight after the birth. Regularly as the clock comes round towards the third hour, *night and day*, for the period named, the child is to be lifted to its mother's breast. This is the first rule of infant nursing. It must not be broken for any reason. It is a great temptation, if the child is sound asleep, to let the hour slip past; and many are proud to tell how the child slept for five or six hours on end. This is a mistake. The child must be wakened at the hour and sufficiently roused and kept awake till it has taken a proper quantity of milk, when it will, in all probability, drop off at once to sleep again. On the other hand if it has been allowed to sleep for five or six hours, the chances are that wind has collected in its stomach and bowels, and its next drink will be followed by an attack of colic and a screaming fit. The mother or nurse will pay dearly for her five or six hours' rest by half an hour's entertainment of this sort. If, on the other hand, the rule is strictly followed, the child will fall in with the regular ways almost naturally. Within a couple of days the mother will have no need of a clock to regulate her suckling. The child will wake up at the hour with almost perfect regularity, will go to sleep after its drink almost immediately, and in ordinary circumstances will give no trouble whatever. Each breast should be given alternately. Often one nipple is hacked and very painful, and the mother shrinks from giving that breast, and delays. This is a most serious mistake, and the greater evil of a "gathered" breast may be the result. To prevent such results the slightest crack of the nipple should be treated thus: carefully dry the nipple after each suckling and place over it a pad of cotton wool, the centre of which is soaked with glycerine of tannin (obtained from druggists). Before the child is again put to the breast remove the wool and bathe off the glycerine of tannin, which is again applied when the child is removed. If this is not sufficient to heal the hack, then let the mother secure without delay a glass nipple shield with india-rubber tube and teat attached, as shown in the Plate of Nursing Appliances. Usually the shields are sold with the teat on the end of the glass, no tube intervening. It is better to have the tube, because by it the mother may apply the shield and herself suck till the milk fills the tube, then putting the teat into the child's mouth. Thus the child is not worried by sucking in vain for some time. The shield should be worn at each suckling, and the wool with glycerine of tannin applied in the interval till the nipple is quite healed.

Usually mothers err by giving the child drink too often. If the child is the least peevish or fretful, the nipple is forced into its mouth to stop its crying, and the child, whether hungry or not, instinctively begins to drink. Should the fretfulness have been caused by the uneasy feelings of an overloaded stomach, this only increases the evil.

The mother must also take care that the child does not drink too much at one time. It usually indicates itself when it has had enough by withdrawing from the breast. It should, therefore, be allowed to drink till it voluntarily leaves off, and should not be urged to resume it again. If, as is frequently done, the nipple be again put into the infant's mouth, the mere contact calls into play the instinctive act of sucking, with the result that more milk than is needed is taken, the stomach is overloaded and may soon indicate this by rejecting some of its load, or, if it remain, the child is uneasy and restless for some time afterwards.

It sometimes happens that a proper flow of milk is not established for several days after the birth of the child. It may be no milk is forthcoming for a day or two. In these circumstances the child should still be put to the breast occasionally to excite the gland, but it must also be regularly fed. For this purpose a mixture of one-third cow's milk and two-thirds warm water, barely sweetened with loaf-sugar, or, better still, sugar of milk, is the best. It should be given, *not by spoon, but through an ordinary feeding-bottle*, to accustom the child to the use of the nipple. As the mother's milk is gradually formed, the supply of this mixture should be diminished, till, with an abundant supply of the former, the latter is entirely withdrawn.

The first breast milk is of a peculiar character. It is thicker and of a yellower colour than ordinary breast milk, and is called **colostrum**. It usually acts upon the child's bowels, and aids the expulsion of the material present when the child is born, which is usually of a dark offensive character. It is beneficial, therefore, to the child to get this first milk, and *it makes it unnecessary for the child to have any other opening medicine.*

A nursing mother will not take long to discover that the qualities of her milk vary with her state of health, and with the character of her diet. If she is honestly doing her duty towards her child, she will soon regulate her own food by the one condition of its agreeing

with her infant. Her food must be abundant, for it must supply the wants of herself and her child. The intervals between each of her meals ought not to be too prolonged. Four hours or thereby is as long an interval as is advisable. If she has fasted long, and, before herself taking food, suckles her infant, the child is apt to be disturbed and uneasy. The food should be plain and nourishing, abundance of milk, bread and milk, porridge and milk, milk puddings, eggs, fish, soups, flesh and fowl, prepared in simple methods. Highly spiced dishes, with pastries and puddings, green vegetables, uncooked fruits, cheese, &c., are very likely to call forth very strong objections from the child. Every mother, however, must determine for herself what she can safely take, so far as her child is concerned, for what one mother dare not take without exciting screaming fits in her child, another mother can take without her infant being the least disturbed. As a rule stimulants are not necessary or desirable. If, however, a mother has reason to believe that her milk is not sufficiently nourishing to the child, its quality may often be improved by her taking about one-third of a pint of good stout to dinner, and perhaps the same quantity towards evening.

The milk is profoundly affected by the mother's state of mind and body. If she has been overfatigued, if she has been worried or annoyed, her child is likely to suffer, and to add to her troubles. But nothing so quickly and seriously affects the quality of the milk as sudden emotion, passion, or excitement of any kind, a sudden fear, or fright, &c. The bad effects exhibited in the child are sometimes extremely serious and prolonged. Therefore a mother should endeavour to maintain an equable and calm frame of mind. She should avoid all undue excitements, pleasurable or painful. She should always have her due amount of sleep, and a daily moderate amount of exercise. The quality of the milk is affected by another circumstance. As a rule so long as the mother continues nursing her monthly illness does not return, and also as a rule she does not become again pregnant. But the rule has numerous exceptions. It is very seldom that the monthly illness of a nursing mother returns soon after delivery, but not so uncommon for it to return about the sixth or seventh month. During the period of the illness the milk is impaired in quality, and the child is likely to be fretful and its digestion to be disturbed. If this happens while the infant is still quite young it may necessitate the mother giving up nursing, but if the child is already six or seven months old it need not cause any inconvenience. The child is probably already having some artificial feeding, and during the period of the illness the breast may be withheld more than usual. It rarely happens that pregnancy occurs during nursing except towards the end of the nursing period. If it do occur nursing must be given up.

To repeat: *up to the age of four or six months the child is to be fed entirely by its mother's milk; it should be put to the breast at regular intervals of about three hours at first, nothing, neither the child's sleep nor the mother's, being allowed to interfere with this arrangement, which is carried out by night as well as by day; after ten days or a fortnight, the child being healthy and vigorous, the interval may be slightly lengthened through the day, and lengthened to four hours during the night.* After a month or five weeks it will often, by judicious management, be possible for the mother to arrange to have a moderately long night's rest, uninterrupted. If the child is suckled about 10 or 11 at night, it may be allowed to sleep on till 4 or 5 in the morning, without a further supply of food. If the child is ordinarily strong, the mother will be able by the exercise of a little patience and perseverance, to gradually train the child to this habit; and its value for herself is very plain. But she will only succeed by herself being strictly regular in suckling the child at the proper times.

Should there be, as there often is, any sufficient reason for a mother not suckling her child, there are two methods of rearing the infant. The one and by far the more preferable method is to secure the services of a wet-nurse. In many families the expense is a fatal objection to this method, however desirable it may be. The second method is to rear the child with artificial food, to rear it "by hand," or to "bring it up on the bottle," as people say.

The choice of a wet-nurse should be made with care. She should be in evident good health, but should also be carefully examined to be sure that she is free from any communicable disease, like consumption and syphilis. For this purpose her teeth, gums, throat, skin and hair, and glands of the neck should be inspected. It is well also to learn the character of her husband, and his state of health. Her breasts should be firm, and should have the knotty irregular feeling of glandular structure, not fat and flabby. The nipples should be well formed, and free from fissures. In order that her milk should be suitable, as regards age, to the child,

she should have been herself confined about the same time as the mother of the child she is about to nurse, and rather later than earlier. Her milk should be examined. It should be bluish-white, sweetish, and should yield on standing a considerable quantity of cream. *The best test of the excellence of the nurse is the appearance of her own child.* If it present any skin eruption, cracks or fissures of the mouth or nostrils, or blotches about the buttocks, she should be rejected.

The wet-nurse should follow the same rules as to frequency of suckling the child as have been laid down for the nursing mother, and her own habits of life must be carefully regulated. Her food should be plain, nourishing, and at regular intervals. She ought not to need stimulants of any kind, neither porter nor beer. She ought to be cleanly in habit, ought to go early to bed, and rise early. She should have stated daily exercise. *Next to the quality of her milk, the quality of her temper is of the most importance.* A bad temper ought to be a fault not possible of being overlooked. It is a strong objection to continuing a wet-nurse if her monthly illnesses return. It ought to be unnecessary to add that the wet-nurse should be carefully and constantly superintended, no matter how trustworthy she may be.

Artificial Feeding.—If a wet-nurse be for some reason or other not obtainable, then the child must be brought up "by hand." *Milk must be prepared so as to resemble as nearly as possible what the mother's milk would be.* Asses' or goats' milk affords the nearest approach. It requires being diluted with water, but no sweetening. Cow's milk, however, is that most easily obtained and most generally used. When artificial feeding becomes necessary it is of the utmost importance that milk of the same cow be regularly obtained, and to secure this arrangements should be made with dairy people who themselves keep cows. For the newly-born infant one part of cow's milk should be mixed with two parts of boiling water, sugar (preferably sugar of milk, obtained from druggists) being added just slightly to sweeten. The mixture should be given through a feeding-bottle. It should be made freshly every time the feeding-bottle is replenished, none being added to the bottle while some milk is still in it. Before each refilling, the bottle, cork, &c. should be carefully cleaned with boiling water, and a fine brush should be used for cleaning the tubes. In fact, after being used, the bottle and tubes should be scalded with boiling water, and then laid aside in a basin of pure cold water till again required. After the first fortnight equal parts of water and milk should be used, as the strength of the child may indicate, and gradually the amount of water diminished, till about the sixth month pure milk is being given. The milk *should be given at the same degree of warmth as the mother's milk would be.* Tested by a thermometer this would be about 98° Fahr. A suitable heat is obtained by diluting the cow's milk with hot water in the proportions named. It may also be managed by placing the feeding-bottle with the mixture in it in a basin of warm water.

As to the quantity required by the child, it is not well to adhere too sternly to hard-and-fast rules. If the child is well managed it will itself be a thoroughly reliable informant as to the needed quantity. As soon as it has had enough it will show a disinclination for more, and this indication ought to be at once accepted and no further supply urged on it. It should get its drink every three hours during the day, and every four or so during the night, for the first several weeks after birth, just as the sucking child does, and if regular habits like this are encouraged, it will take its due supply, no more and no less, and go to sleep again. As it grows older it will desire more at a time, and the intervals may be lengthened. So that a healthy well-managed child will itself quite plainly tell what quantity of milk it needs. As a rule, however, an infant takes from the breast about six table-spoonfuls of milk at each suckling during the first and second months of life. Week by week it takes more and more till, at the age of ten months, it will draw three quarters of a pint and upwards. By the end of the first month an infant fed by hand should be taking upwards of a pint (a pint is equal to 20 ounces—or 4 gills), say 5 gills in 24 hours. At the end of two months it should have nearly a pint and a half, between 5 and 6 gills. At the end of three months it should have between $1\frac{1}{2}$ and 2 pints, between 6 and 8 gills, and so on.

It often happens that cow's milk does not agree well with the infant. It is certain that a child "brought up on the bottle" does not, as a rule, thrive so well as one brought up "at the breast." The child often vomits the milk soon after it has been swallowed, and is affected with colic and looseness of bowels. The milk, as vomited, is usually in large curdled masses. Now the curdling of the milk in the stomach is the first stage in the process of digestion, is a natural process, therefore, and

does not indicate anything wrong, as many mothers and nurses suppose. But cow's milk curdles in larger and more solid masses than human milk in the process of digestion. Human milk forms finer and more flake-like curd. The large solid curd of cow's milk is, therefore, more difficult to digest, and more liable to irritate an infant's stomach than the soft fine curd of human milk. If there is any difficulty in getting the cow's milk to agree with the child, it is well, first of all, to try the effect of boiling the milk before using it. The effect of boiling seems to be to cause the milk when it reaches the stomach to curdle more slowly and in smaller masses. Before trying any other course, however, the mother or nurse ought to assure herself that there is not some simple and obvious reason for the milk disagreeing with the child. She ought to see that the child is not being fed too often, that it is not getting too much at one time, and so on. Many get into the extremely bad trick of quieting a child, on the least suggestion of its crying, by thrusting the teat of the feeding-bottle into its mouth. They allow the bottle to lie by the child's side in the crib, and permit it to suck, at odd moments, all day long, letting it even drop off to sleep with the teat in its mouth. This is purchasing domestic peace at the price of the child's health. For there is no surer way, in the long run, of completely disturbing the child's digestion, and of setting up indigestion, colic, looseness of bowels, sickness and vomiting, than this. Therefore, before mother or nurse concludes that the milk is not agreeing with the child, let her see that no such bad practices as these enter into the question. If the milk is still vomited, let the child be fed with small quantities frequently repeated. For a day or two let it have two tea-spoonfuls of the milk every 20 minutes or so, and nothing else. Find, in short, the smallest quantity that the child's stomach can tolerate at one time. The smaller the quantity, the more often must it be given. The chances are that speedily all vomiting will cease. After it has stopped for a day or so, gradually increase the quantity given and lengthen the intervals in proportion. The probabilities are that, if this method is carefully pursued, in a few days the child will be taking the ordinary quantities of milk at the proper intervals without any bad symptom. If, however, it is impossible by such means to get the cow's milk to agree with the child, a change must be made. If goat's or ass's milk can be obtained, let it be used, diluted, but not sweetened. Failing this, let condensed milk be employed. Most of the condensed milks contain a large quantity of sugar to aid in their preservation. It is best to get unsweetened condensed milk. It does not, however, keep long, and must be rapidly used. It must not be given too strong. For an infant at birth one tea-spoonful to one tea-spoonful and a half to the ordinary teacupful of warm water ought to be sufficient; and the strength should be gradually increased, as is done with ordinary cow's milk, till at six months of age the child gets a mixture made of 1 part of the condensed milk to every 8 or 10 of water. The unsweetened kind requires, of course, slight sweetening with fine loaf-sugar.

A great many attempts have been made to produce a food for infants resembling human milk, Liebig's food for infants, Nestle's food, &c. &c. As a rule, however, they are all deficient in nitrogenous elements; as a result, although they agree with children, the children are soft, flabby, pale, and deficient in vigour. They have soft yielding bones, are very open to disease, and have no great power of recovery.

In no sort of food is this defect more marked than in such as arrowroot and corn-flour, and to a less but still a marked extent, in sago, tapioca, rice, barley. Yet it is a popular delusion that arrowroot and corn-flour are good for children, and very nourishing. *They are not so.* They consist almost entirely of starch, which the digestive apparatus of an infant is not yet prepared to digest. They are bland in character, however, and are not irritating, but are only nourishing in proportion to the quantity of milk with which they are prepared. So far as the arrowroot or corn-flour themselves are concerned, a child fed mainly on them would waste, would be literally starved.

Oatmeal is nourishing, and in the form of oat-flour, of which good kinds are now to be had, is very suitable even for infants. It should be made as nearly entirely with milk as suits the child's stomach. Entire wheat-flour is now made of a very fine kind for infants and invalids, and is one of the best kinds of such food-stuffs. Biscuit-powder is also manufactured for infants' use by well-known and reliable firms. A useful biscuit-powder is easily obtained by rolling a tea-biscuit of good quality into powder by means of a rolling pin. One or two tea-spoonfuls mixed with equal parts of milk and water and a little sugar and brought to the boiling point offers a very good food for infants. It may be thinned with milk and given from a feeding-bottle.

For purposes of night feeding food warmers

are employed. A useful kind is figured in the Plate of Nursery Appliances. It is usual to keep the food in the dish and the light burning beneath it, so that the food is kept warm all through the night. Kept warm for hours at a time the milk is apt to sour. It is better, therefore, to light the wick and allow the food to warm just before it is about to be used, the food being kept cold till then. For a similar reason it is a mistake to fill a feeding-bottle with milk and keep it warm in bed till required. Changes are thus apt to be produced in it injurious to health.

It is necessary again to repeat that milk is the proper diet, and milk only, for a child up to four and even six months of age, and that, as a rule, if the mother or nurse takes sufficient care in regulating the times of feeding and the quantities, difficulties in the way of digestion will be overcome. It is also necessary to say again that the utmost care must be exercised in keeping the feeding-bottle, tubes, and teat scrupulously clean. A speck of old milk, left in either, will speedily set up fermentation in the new supply, and derangement of the child's stomach, looseness of bowels, &c., are too likely speedily to arise.

Bathing and Clothing.—Nothing conduces so much to the comfort and health of a child as regular bathing from the first day of its life. The infant should have its first bath immediately after its birth. The bath should be large enough to permit the child to be covered with water up to the neck. The water should be at the same degree of warmth as the child's body; lukewarm is the best description of it. If regulated by a thermometer, it should be about 98° Fahr. The child's head and face should be first washed with the clean bath water, and then thoroughly dried with a soft towel, the child meantime lying on the nurse's lap on a warmed flannel cloth. The child should then be placed bodily in the bath, supported by the nurse's hand and arm, and gently sponged all over. A small quantity of fine toilet soap should be used. Special care should be taken to cleanse thoroughly the fold of skin at the neck, armpits, and groins. After the washing the child should be quickly but carefully dried, and then those parts of the skin which rub against one another, the folds of the groin, armpit, neck, &c. should be lightly dusted with fine violet powder. A great many nurses are careless in the drying, thinking the dusting powder is put on for this purpose. This is a great mistake. If the powder is put on the skin still damp it forms a cake; and nothing is more likely to irritate and inflame the child's tender skin and lead to the formation of sores. The skin must first be quite dry, and then the powder applied helps to diminish the friction between the opposing surfaces of the skin. For a similar reason the powder must not be too freely applied, a very fine film of it being all that is necessary.

The bathing process should be performed before a fire, draughts being kept off by a screen.

The newly-born infant often has its skin coated in various places, and specially the head and folds near the joints, with a thick whitish scum difficult to wash off. This is most easily removed with oil, olive-oil, sweet-oil, or butter, if no oil is at hand. The nurse takes a little oil in the palm of her hand, and rubs it over the part gently but firmly till a sort of lather has been produced. A sponge with clean water and a little soap will then readily cleanse the skin. The eyes of a newly-born infant should be specially looked at, every particle of matter being removed with a clean sponge and pure warm water. Any appearance of matter coming from them within the first few days after birth should cause special attention to be directed to them. (See Inflammation of the Eyes of Newly-born Children, p. 458.)

Children should be bathed twice daily, in the morning immediately after rising and in the evening before going to bed, and *always at the same hour*. In fact if the same regularity advised in regard to the giving of food be practised in regard to the bathing, it will add much to the comfort and general health of the child, and will do a great deal towards making the child bright and active throughout the day, and towards securing for it sound refreshing sleep throughout the night.

The evening bath should be the principal one of the day, the child's body being then well washed all over, soap being used; the morning bath need not be much more than a dip in plain water, and sluicing with the sponge. As the child grows, the warmth of the morning bath may be gradually reduced a little, and at six months the child, if it is healthy and vigorous, may be freely sponged in the morning with nearly cold water if the weather is warm. The cool water should only be applied with the sponge, the water in the bath in which the child is set down should be warmer. After the cold sponging the child's body should be well rubbed with a fine towel; and if there is any

sign of chilliness or blueness of the skin, the cold sponging should be stopped and not used again till the child is older. No mistaken notion of "hardening the child" should lead to persistence in the use of water manifestly colder than is consistent with the child's comfort.

Food should be given *after not before* the bath.

Many mothers and nurses abstain from giving the usual bath for very trifling reasons. If the bath is properly given, and if proper care is taken to guard against chills, which ought always to be done, there are very few circumstances, indeed, in which it can do any harm. On the other hand, at the outset of many childish complaints, the warm bath is of the greatest possible benefit. It not only cleanses the skin, and stimulates the activity of the sweat-glands in removing waste substances from the blood, but it causes relaxation of the blood-vessels of the whole surface of the body, and consequently brings the blood to the skin in greatly increased quantity to the relief of deeper parts.

Clothing has for its object the maintenance of a certain regular degree of warmth, and its nature and amount ought, therefore, to be determined by the external temperature. It should vary, that is to say, with the climate and the season of the year. In section XI. it has been explained that the skin plays a very important part in maintaining a regular bodily temperature. When the heat of the atmosphere is higher than the proper bodily heat, it has been explained that the body heat is kept at its due level by the blood flowing in larger quantity to the skin, and by heat lost in evaporating increased perspiration; and when the heat of the atmosphere is less than that of the body, a lowering of the bodily temperature is to some extent prevented by the contraction of the blood-vessels of the skin, diminished sweat, and consequently a diminution in the loss by evaporation. In climates where the heat of the atmosphere is very different from that of the human body, and where the variations are great, men must come to the aid of the ordinary healthy processes of the body. In warm climates clothing is used which reflects, throws off, as much as possible, the heat of the sun, and is, at the same time, fitted to permit of free perspiration, while in cold climates clothing is used to retain the heat of the body and prevent it passing off. While infants' dress ought to fulfil the same purposes, it must be remembered that the heat-regulating apparatus, so to speak, of the child's body is not yet in full working order, and the child is consequently much more sensitive to changes in the surrounding atmosphere, and much more strongly affected by them. A slight change in the heat of the atmosphere, to which a man's body so readily adapts itself that he is barely conscious of it, may strongly affect a child; and this should always be remembered by mothers and nurses.

The second special point to notice regarding infants' dress is that it should be so put on as to interfere as little as possible with all natural movements. This requirement is not satisfied when free movement is permitted to arms and legs; care must be taken that the movements of breathing are not hindered. Most of mothers and nurses make this mistake at the very outset. They apply the binder so tightly round the child's belly and chest, in the delusion that its back is thus supported, that its breathing is greatly impeded; and often permanent injury is inflicted on the lungs. Acting under the same mistaken idea they encase the child's body in stays (so-called), and with a multiplicity of other wrappings reduce the infant to a condition of miserable bondage. A third point worth remarking upon is that an infant's skin is not only very sensitive to changes of temperature, but is also very readily irritated in various ways. The mere mechanical irritation produced by the rubbing of rough cloth, will often cause the appearance of a rash on the skin, and will at least be a source of great discomfort to the child. This is a cause of annoyance not to be overlooked in dealing with a fretful child. For this reason the child should have next its skin some very fine soft material. For the same reason wet napkins should be quickly removed, as well as any other article of dress that has become damp. The skin is very speedily inflamed, and cracks and fissures are very readily caused, by contact with wet clothing, especially when wet with irritating material such as that of the discharges. Before replacing dry napkins the skin should be carefully dried and dusted, if previously sponged so much the better. It may be added that the napkins or diapers should not be washed in water containing soda. Pins, even safety-pins, should, as far as possible, be avoided in an infant's dress. Extreme restlessness, crying, and sometimes even convulsions have been caused by carelessly applied pins, whose points had worked themselves into the child's skin.

What manner of child's clothing, then, best

fulfils the conditions that have been set forth? Flannel ought, undoubtedly, to form the chief part of an infant's dress, a long-sleeved flannel gown from the neck downwards being the principal garment. As, however, the child's skin is apt to be irritated by rubbing against the flannel, a shirt of fine lawn is usually put on next the skin. It is customary also for a roll of flannel—a binder—to be wound round the belly. During the early weeks of the child's life this is valuable, by giving protection and support to the navel. *But it is almost constantly too tightly drawn*, and seriously interferes with the action of the chest and belly, greatly impeding breathing. It should always be so slack that the hand can be readily passed between it and the skin. The use of the binder should not be continued longer than six or eight weeks. After that time it should be daily made narrower and shorter till in a few days it is entirely given up. The flannel dress should be fastened by means of buttons or tapes, even safety-pins being not devoid of danger, and it should extend for 10 inches or so beyond the feet to keep the legs warm. It should never be so tight-fitting at any part as to limit freedom of movement. A light woollen shawl, to be thrown over the child when it is being carried from one part of the house to the other, completes all its necessary clothing. The head needs no special covering indoors, either by day or by night. When the child is taken out, it requires a covering for the head, a soft, light woollen hood being preferred, and it also needs an extra wrap, a woollen shawl being the best. If a cloak is used, the mistake should not be made of fastening it on by tying round the neck only, half strangling the child, as it too often does. The thickness and closeness of the material forming the added garment should depend upon the weather and season of the year. About the third month of life, when the child begins to exercise its limbs more freely, its clothes are usually shortened. Stockings and soft pliable shoes become necessary. The clothing at this period commonly consists of a linen, cotton, or flannel shirt next the skin, of a pair of stiff-starched cotton stays, of a flannel petticoat made with a body, an outer cotton one, and of a dress with short sleeves. There are some objections to be taken to this arrangement. The shirt should always be of flannel, unless that has already proved too irritating. The stays are worse than useless, they are positively injurious, a hindrance alike to free movement and free growth. There is no justification of any kind for retaining them. Instead of each petticoat having a body of its own, or being simply buttoned at the waist, a light flannel body should be made separately. Round the waist it should be provided with buttons to fit corresponding button-holes in the petticoats. With this arrangement, if one petticoat be wet it can be removed at once without undressing the child. From the waist-band of this body suspenders for stockings can be attached. The dress should always have long sleeves, and should not be low-necked.

For night a woollen night-dress should be provided, but no night-cap or other covering for the head.

Exercise, Air, and Sleep.—Even the very young infant derives great benefit from such exercise as is directly possible to it, as it lies free and unrestrained on its mother's or nurse's lap. For this reason the washing and dressing of a child should be leisurely rather than hurriedly performed, provided care be taken against the risk of cold. Even the youngest infant should be accustomed to the open air, carried in its nurse's arms. The daily airing should be a regular ceremony, on dull as well as on bright days. The child should have extra clothing according to the season and the state of the atmosphere on the particular day; and the face should be protected by a light veil. With such precautions the child will not be affected by moderate changes of weather; and it will seldom be necessary to prohibit its going out. At first, of course, the infant is to be taken into the open air for only a few minutes at a time, fifteen to twenty, and the time is to be gradually extended as seems desirable, and according to the state of the weather. Carrying in the nurse's arms is better than wheeling in a perambulator. The motion of the perambulator is not so agreeable, and the child is apt to become stiff and chilled in a constrained position.

As regards rest, the infant passes most of its time asleep, and it is, therefore, important to make no mistake regarding its bed and bed coverings. From its birth the child should sleep in its own bed and *not with its parents or nurse.* A wicker basket, lined inside, provided with a firm mattress, covered by a small blanket, a small, not too soft, pillow, and a miniature pair of blankets and down quilt, form a very comfortable sleeping-place. The bassinet should be raised off the floor. Children are commonly kept too warm in such little cots, coverings being heaped upon them, curtains being drawn round

their heads, so that they are often completely covered up, no regard being paid to the means by which fresh air is to reach the child. As a result when the child is lifted out of the bed, it is streaming with moisture, its head being bathed in perspiration. Care is certainly to be exercised to prevent draughts sweeping below the crib or round its head, but the basket should be freely open in front towards the child's face, which should never be covered up. Perspiration bursts out over the child's head if the pillow is so soft that the head sinks down into it. Down pillows and mattresses are, therefore, bad. The pillows and mattresses should, on the other hand, be firm enough to offer sufficient though gentle support to the child.

The excessive warmth to which the child is usually subject in its cot is not so injurious even as the bad air which it is so frequently caused to breathe. Not only, therefore, must curtains not be drawn round its head, but care should be taken to ensure that the room in which it sleeps is duly and properly ventilated, but so as to avoid draughts. The opportunity should also be taken whenever the child is out of the apartment to air it properly. The room should be directed to the south, if possible, and air and sunlight should have free access to it, for air and light are as necessary for healthy growth as food. It is always advisable to regulate the warmth of the room by means of a thermometer, instead of leaving it to the feeling of parent or nurse, and the heat should be kept as regular as possible, the mercury standing at 65° Fahr.

Use of Medicines.—As a general rule if infants are properly managed they require very little medicine of any kind. But with many people it is a matter of custom to give a dose of castor-oil, or magnesia, at regular intervals, every two or three days, or once or twice a week. According to their view, the child could not possibly continue well without such meddlesome interference. From the day of its birth onwards for the slightest reason, and frequently without reason, the child is dosed with opening medicine. The result is that irregularity of the bowels is set up, and a great amount of harm done which it is very difficult to rectify. Now a healthy infant needs no medicine whatever as a matter of course, and the giving to it of medicine of any kind ought to be an unusual rather than a customary practice.

The first milk drawn from the breast of a nursing mother is of a peculiar character and is called **colostrum**. It has an opening effect on the child's bowels, and the first material passed from the child is usually of a dark brownish colour. There is, therefore, no necessity for the newly-born child, that is being nursed by its mother, getting opening medicine, for that has already been provided for *by nature*. This is one of the reasons why the child should be put to its mother's breast shortly after birth. After this the child's bowels ought to move naturally twice or three times in twenty-four hours, and the stools should be of the thickness of thin mustard, of a light yellow colour, free from lumps or curdy-looking masses, and passed without pain or disturbance of any kind. Frequently the motions are greenish, very offensive to the smell, and lumpy with white portions of curd, and to remedy this it is usual for the nurse at once to resort to the use of castor-oil, magnesia, or other medicine of a like effect. Now the cause of this condition is commonly bad methods of management. The child is geting too many drinks, or too much at a time. The curd is simply portions of undigested milk passing unchanged through the bowels, because the bowels are unable to digest the large quantity passed into them at one time. The remedy, at least in the first instance, is to correct the bad nursing, to give the child the breast less frequently, or to give it less at a time, or to do both these things. If the mother or nurse will really put it to herself that she is to blame for the state of the child's digestion, and will correct the mistakes she is making in suckling, the natural condition may be restored without the use of medicine. One of the results of this improper feeding is that the infant is troubled with wind and is much pained. For that reason, also, the mother hastes to give medicine instead of setting right her improper ways of nursing. If, however, the bowels continue for two or three days in this state, and the child is very fretful and uneasy, it may be desirable to give one dose of medicine, effectually to clear out the bowels, and permit a fresh start. For this purpose one or two tea-spoonfuls of castor-oil are the best means. But the mother must not forget that the relief will only be temporary, unless she takes care to manage the child better for the future. The same general principles should be the guide in rearing a child that is being brought up on artificial food. Here, it may be necessary to give medicine to secure a motion within the first two days after the child's birth, because it is not getting the benefit of the first milk of its mother. Castor-oil is here again to be given, and thereafter regularity of the

bowels is to be secured by attention to the feeding rather than by any giving of drugs. There are numerous cases where from its birth the child exhibits a tendency to costiveness, the proper methods of treating these cases are mentioned further on (p. 462). *The rule to be remembered, however, is that regularity of movement of the child's bowels is to be secured by proper feeding and not by medicines.*

Opening medicines are also the common resort when a child seems troubled with any irritability of the stomach. If it vomits its milk, and specially, of course, if this happens frequently, it must be dosed with some drug or another. Here, again, in all probability the fault is the mother's. It is commonly an overloaded stomach that is indicated; the child is allowed to take, or is forced to take, too much milk. Perhaps the mother's breasts are very full, and the milk flows so freely that the child can scarcely drink fast enough, and gulps it down, or perhaps the mother puts the nipple again and again into the infant's mouth, and encourages it to take more, when by withdrawing its head, it has already indicated its satisfaction. In such cases the vomiting is simply nature's method of disposing of the excess. When mothers see this, their business is to try to make the child drink more slowly, to take away the breast when they think the child has had enough, and never to urge it to take an extra supply. As soon as this has been done, probably the vomiting will cease. If, however, medicine does seem needful, then it ought to be a simple dose of one or two tea-spoonfuls of castor-oil, or two or three tea-spoonfuls of fluid magnesia repeated occasionally for a day or two.

Many people find it very difficult to give medicine to infants. The child can easily be held on the left arm, propped up with its head resting on the shoulder and held so by the arm gently pressing the head against the person's chest, the hand of the same arm being brought round in front to hold down the infant's hands. The medicine is taken in a small spoon in the right hand, and gently, but firmly, introduced into the mouth far enough to place the medicine well back on the tongue. If this is properly done the child cannot help swallowing it. *Only a small quantity should be* taken on the spoon at a time, about a quarter of the spoonful, and when that has been disposed of a little more is given, till the necessary quantity has been swallowed.

A second thing which some nurses are too ready to do is giving the lately-born infant a little gin and water or a little spirits of nitre and water, because the child has not made water, or what they think not enough. This must never be allowed. A small quantity of water may be made but be unnoticed, because of being soaked up by the cloths. Even though it is quite certain that no water has been made, drugs must not be given. A pad of flannel wrung out of moderately warm water and placed over the lower part of the belly and between the legs will usually be sufficient to encourage the flow. This application may be repeated for several times. Nothing else should be done without medical advice.

Stimulants of any kind should never be given to children by parents or nurses. A doctor may find it advisable to administer them in certain cases, but on no account should others employ them without medical orders.

Some form of stimulant is often given to dispel wind, but there are some harmless drugs, such as dill water or essence of anise, which are equally satisfactory in their action. The method of giving them is mentioned on p. 461. But again it cannot be too strongly insisted on that flatulence and similar disturbance of the bowels are due most frequently to bad management in suckling or feeding, and that that evil should be rectified. The practice of giving to children, and specially to infants, what are insinuatingly called *soothing medicines* cannot be too strongly condemned. The effective ingredient in the most of these compounds is *opium* in some one of its forms. Laudanum itself, the tincture of opium, is frequently given on sugar by unscrupulous nurses or careless mothers, to quiet a fretful child, whose pain, restlessness, and sleeplessness are due to wretched mismanagement or gross inattention. Even mothers who would not dream of giving laudanum or opium to any of their children are glad to make use of preparations in which the opiate is masked by some special name, such as Mrs. Winslow's Soothing Syrup, Godfrey's Cordial, Dalby's Carminative, syrup of poppies, &c. &c. In each of these it is the contained opium that produces the so-called soothing effect, and each is capable, if used in sufficient quantity, of inducing a "quietness" that will not again be broken. *One drop* of laudanum has killed a child, and numerous cases of infants' deaths have been reported in medical journals from the use of Mrs. Winslow's remedy, and from such preparations. Medical men themselves are extremely chary of administering opiates in any

form to young children, even in cases of serious disease where their use seems demanded, and when they do feel compelled to use them they are extremely careful in prescribing the dose and in watching its effects. *Children are extremely susceptible to the action of opium.* This must never be forgotten, for of some other drugs, of which *belladonna* is a good example, they can "stand" a larger quantity than most grown-up persons. It ought then to be a rule, never departed from, that neither opium nor any of its preparations, nor any compound in which it exists, is ever to be administered by mother or nurse to a child. Mothers who intrust their children largely to the care of nurses, cannot be too careful in seeing that the nurse does not *secretly* employ such remedies to give herself greater ease and convenience by drugging her charge to sleep.

To sum up, the only medicines parents or nurses need have at hand are castor-oil, magnesia, and dill water. If they are kept at hand in case of being required, they should, nevertheless, be sparingly used. The child, it may again be repeated, ought not, in ordinary cases, to be *restored* to a proper condition by the use of medicines, but ought to be *kept* in a healthy state by proper feeding and general careful and watchful management.

Premature children.—It is only necessary to say a word or two about the extra care required for children born before full time. The more near the infants are to the full period of nine months, the greater is the likelihood of careful nursing enabling them to survive. It is a vulgar notion that a seven months' child has a better chance of continued existence than an eight months' child. This is not so. A child that has passed eight months within the womb is in every way more developed than one that has passed only seven months, and its chance of survival is consequently proportionately increased. The chance of a child born before the seventh month is comparatively small. Nevertheless there are numerous cases on record of infants, born between the sixth and seventh month of intra-uterine life, surviving and thriving satisfactorily. The two difficulties are those of feeding and keeping warm. The child is often too feeble to suck, and artificial feeding is necessary, because the mother has no milk. If the child can be made to suck, milk prepared as directed on p. 438 should be given from a feeding-bottle. To aid the child a small teat should be used, and the nurse should see that the milk can be drawn easily. The child should take from four to six table-spoonfuls at one time, and should get a drink at intervals of an hour and a half to two hours, and more frequently if a less quantity is taken at each time. If the child cannot suck, the milk must be given with the spoon, and it is better to give small quantities at frequent intervals, two to three table-spoonfuls every hour, than to attempt to give larger quantities less frequently. With premature children the difficulty of maintaining the bodily heat is great. To secure this it is sometimes necessary to surround the child, face excepted, with cotton wool. Care must also be taken with the skin, which is very tender, easily ruffled and inflamed.

Vaccination.—This is compulsory by law in Great Britain within the first six months of infant life. The purpose and value of vaccination have been fully discussed on pp. 406–409. It may be advisable to re-state here that a child should be vaccinated between the second and fourth month after birth, before teething begins, but that if small-pox be prevalent at the time, and if there be any danger of infection, it cannot be vaccinated too soon. *There is no risk at all to be compared to that of catching small-pox in vaccinating even the day after birth.* It may also be again stated that if the vaccine matter is taken from a healthy child on the eighth day after its inoculation, and if proper precautions be observed in taking the lymph to ensure that only lymph and no blood be taken, there can be no risks whatever of transferring any disease. Further, the extremely painful, red, and swollen arms that one occasionally sees are in most cases due to the carelessness of the mother or nurse in not properly guarding the arms from injury by rubbing or in other ways, and specially to badly-adapted clothes which compress the parts at the armpit and lead to inflammatory swelling of the whole arm. The full measure of safety is secured when four good vaccination marks are produced. The mother, therefore, should allow the child to be vaccinated on four "places" if she wishes the utmost benefit of the operation. Many doctors vaccinate only on two "places," and if the district where the children live and are likely to remain is commonly free from the disease, so that the risk of infection is slight, two marks may be satisfactory enough. Vaccination on only one place, however, is too little to be satisfied with. If, however, there is any risk of infection in the neighbourhood where the child lives, or if there is any likelihood of

the persons removing to any district where there is risk, vaccination should be performed on four "places" to secure the greatest amount of protection. If children are well managed they should give comparatively little trouble during the period when the vaccine is operating on the body. Careful dieting, the usual attention to bathing and cleanliness, attention to the bowels, and care to prevent injury and irritation to the arm, ought to ensure little disturbance. If the child suffers at all it will be between the seventh and tenth days, when it may be hot and restless, and the bowels slightly disordered. A tea-spoonful of castor-oil, or three or four tea-spoonfuls of fluid magnesia is all the necessary treatment. The heat of the vaccinated part may be soothed by placing lightly over it, if it seems needed, a piece of lint soaked in cold water, and keeping it soaked. If the lint is allowed to dry, it will adhere to the part, and attempts to detach it will cause still more pain than before.

Some children, comparatively few, however, fail to take the vaccination. By the Vaccination Acts the operation must have been performed three times and failed each time, before the child is declared insusceptible. If this has been done the doctor will give a certificate to that effect. But it would be well if the operation had failed twice with lymph obtained in the ordinary way, that it should be tried the third time with calf lymph.[1]

Should a child not be in good health, a medical man may, if he deems it advisable, postpone the operation to a period beyond the legal six months by signing a certificate to that effect.

Revaccination is considered on p. 410.

THE MANAGEMENT OF CHILDREN BETWEEN THE SIXTH MONTH AND SECOND YEAR OF AGE.

Food.—Up to the sixth month the child has either been nourished entirely by the breast milk, or by milk food given through a bottle, or by the breast milk supplemented by the bottle food. By this time it becomes necessary to make considerable additions to the diet. If the child is being suckled, and the mother has still a good supply of milk, the addition should consist of one meal per day, given about midday. It should be made of milk thickened with some well-boiled fine entire wheat-flour, or oatflour, or ordinary wheaten bread boiled with milk and sweetened. Biscuit powder may also be used, or a scalded rusk. This should be made of a thickness that will permit of it being drawn through the bottle. A good food is made of the following:—

Malt	½ ounce.
Second Flour	½ ,,
Skimmed Milk	6 ounces.
Water	1 ounce.
Bicarbonate of Potash	7¼ grains.

Grind the malt in a mortar or coffee-mill; mix all the ingredients together; put in a pan thoroughly clean, and place by the side of the fire so that it becomes just lukewarm for 15 minutes; thereafter boil for 6 or 8 minutes; strain through a sieve or muslin, and give through a feeding-bottle. Some mothers, however, who regularly suckle their children, and have a strong objection to feeding-bottles, prefer to give such an addition to the diet in the form of spoon food, and there is no objection to this: the food only requires to be made thicker. Beginning with one meal a day of this kind, the child may soon get a second meal of a similar kind, the frequency of giving the breast being correspondingly diminished. If the mother's milk is rapidly diminishing, it is common to feed the child through the day, and give the breast only at night. It is better to give the breast once through the day and once through the night, and to give the other food at regular intervals between these times, contriving to give the last spoon or bottle food just before it is customary for the mother to retire so that she may not be disturbed till towards morning. It is too long an interval for the milk to stay undrawn in the breast between one night and the next, and therefore advisable for the child to be put to the breast once during the day. If the child is being brought up by hand, then the addition to the diet can be made at one of the ordinary times of feeding. In every case, however, the same regularity in respect of time of feeding, and the same care against overfeeding, must be exercised as have been already recommended in the management of the newly-born child. If one form of food disagrees with the child let another be tried. Derangement of the stomach and bowels is to be met by a change of diet rather than by the giving of medicines.

[1] There are several associations now in London for the supply of pure vaccine lymph, calf lymph as well as human lymph. The writer has had every reason to be satisfied with calf lymp obtained from the Association for the Supply of Pure Vaccine Lymph, 12 Pall Mall East, London, of which Mr. Ed. Darke is secretary. Half-tubes, sufficient for one child, are obtained through the post for 1*s.* 1*d.*

By the time the child is eight months old a further addition to the diet should be made by giving once a day a small quantity—a small tea-cupful at most—of beef-tea or weak chicken or mutton broth or soup from which all vegetables have been removed by straining through muslin and from which fat has been skimmed. The beef-tea is best made by scraping the meat with a knife. Place the scrapings in a jelly-can with two breakfast-cupfuls of *cold* water to each quarter of a pound of beef; set the jelly-can in a pot of hot water, covered with a lid, and allow the water in the pot to simmer for two hours or so. Salt the beef-tea to taste. It should contain all the valuable parts of the beef in fine flakes and should need no straining. If this tends to make the child's bowels too loose, that may be remedied by slightly thickening the tea with rice or corn-flour and boiling it for some minutes.

Weaning should be effected when the child is ten or twelve months old, the exact time being dependent upon the health of mother and child. It will be begun earlier if the mother is suffering from nursing, and delayed till later if the child is weakly and the mother able to bear prolonged nursing and having good milk. The period named is generally chosen because the child usually has about that time an interval of rest between cutting the front teeth and the first of those at the back. It is often a process involving some trouble to the mother and discomfort to the child, but, if the above directions as to feeding have been observed, the child will really have been in preparation for it since the sixth month, and much of the difficulty will be overcome. Weaning should not be allowed to take place if the child is suffering from the irritation of late teething, from any cold, or feverish attack, or trifling illness, but the mother should wait till that has passed off. The process should be performed gradually; as the breast-milk is withdrawn its place should be supplied by other appropriate nourishment. The child's food at this time should consist largely of milk and of the preparations of milk already mentioned, including well-boiled milk porridge, the diet being properly varied from day to day, though given at the same regular intervals, the cup of beef-tea or weak mutton broth being given once a day. At this time, too, a lightly-boiled egg beat up and properly seasoned, given with bread and milk, will be as a rule much relished. The mid-day meal may be thus varied, the egg being given instead of the beef-tea or broth. As the child grows older and more vigorous the quantity of animal food in the diet is to be carefully increased. At about fifteen months of age it may occasionally get a small quantity of well-boiled mealy potato, thoroughly bruised down in its beef-tea or in gravy, and the mid-day meal may also be added to by some light milk-pudding. Before this age no solid animal food whatever should be given. It will be receiving sufficient animal food in a semi-fluid form in the beef-tea, broth, beat-up egg, and so on. But between the fifteenth and eighteenth months the child may be tried with a little meat, if it be scraped down into a fine pulp and given with gravy and a little well-mashed potato. A small piece of chicken may be given in the same way. White fish will also be found usually to agree well with the child's digestion. At about two years of age the child should be getting four regular meals a day:—breakfast of well-boiled porridge and milk, bread and milk, or egg with bread (lightly buttered) and milk; a mid-day meal of beef-tea, broth, or soup, with a little well-mashed potato, and afterwards some light milk or egg pudding, or some well-chopped-up meat—beef or mutton—or fish or chicken, with potato and pudding afterwards; a tea of bread, butter, and milk, and the bread may be spread with jelly, honey, or syrup instead of with butter; and for supper bread and milk. Some regard should be paid in dieting to the relation of the meals to one another. If the breakfast consists chiefly of porridge and milk, or bread and milk, the dinner should contain a good proportion of animal food in the shape of egg, fish, or butcher-meat of some kind. For it must not be forgotten that at this age the child cannot obtain sufficient flesh-forming material from oatmeal or bread, and still less from rice, sago, corn-flour, or such substances. It cannot even drink sufficient milk to supply this want. The result will be that, if animal food is not supplied, the child will be soft, with soft bones and flabby muscles, wanting in sustained energy. The necessary animal part of the diet should therefore be made up at breakfast or dinner, and if, owing to the nature of this meal, on some occasion it is in deficient quantity, it may be made up at tea by a part of an egg or a whole egg. Animal food should be given preferably at mid-day. The meat should be boiled or roasted. Salted meats, pork, veal, and lamb are to be avoided. A small quantity of vegetable may also be allowed when the child has reached two years of age, potato as already mentioned being given earlier than that age, if

not new and if mealy and well mashed; but by two years carrot, turnip, and cauliflower, well boiled, may be permitted in small quantity, not cabbage or green vegetables. Soft green peas may be allowed. Some cooked fruits—stewed apple or prunes—will usually be relished given with well-boiled corn-flour or rice, but uncooked fruits are injurious, except the orange when in season, the child being taught to reject the skin and seeds. Pastry and nuts are to be avoided. The diet recommended will strike many people as generous, and liable to lead to overfeeding. It will not do so if the child receives its meals at regular times, and does not get additional food at odd moments. If a child has its regular meals it will take at each what satisfies it and no more, provided an undue variety of dishes be not produced to stimulate its appetite. But if in addition to its own meals it is permitted partly to share its parents', then overfeeding or digestive troubles will likely arise. As great an evil is the giving of sweet biscuits, pieces of bread and jelly, and so forth, between meals. Parents should from the first entirely set their face against "pieces" between meals. They prevent a healthy appetite at the proper meal-time, and derange the digestion besides. As a rule also sweetmeats are given very indiscriminately. An occasional sweetmeat is not hurtful, if only one be given occasionally. Those made entirely of pure sugar, or a gum pastille, or a small piece of chocolate may be given, *but only occasionally.* Any containing almonds, nuts, &c., should be avoided. Similarly, cakes with raisins, currants, &c., should not be given. Plain sponge-cakes or plain biscuits alone are admissible, but ought to be used at meal times as an addition to the meal, and not between meals.

Finally, children should be taught to take their food slowly and to chew it thoroughly.

The only **beverages** for children are milk and water. The practice of giving small quantities of wine, malt liquors, or stimulants of any sort for little ailments is hurtful in the extreme; still more is the habit of giving these things as a matter of course a most pernicious one. Stimulants should be given to children only on the direct order of the medical attendant, and then only in the small doses he orders, which should be carefully measured. As regards tea, many parents like their children beside them at table, for one meal at least, when they reach two or three years of age, and tea is often the meal. The child may have its cup of warm milk and water sweetened, and if it be barely coloured with tea no harm is done, but it ought not to be more than barely coloured. Thin cocoa, made mainly with milk, is, however, quite digestible for children and also nourishing.

Teething. The first set of teeth are called the **milk-teeth.** They have usually all appeared above the gum by the end of the second year of life, or from that to the thirtieth month. The full set consists of twenty teeth, ten in each jaw. The ten are formed of four central **incisors,** or **cutting** teeth, one **canine** or **eye** tooth at each side of these four, and two **molar** or **grinding** teeth at the back on each side. They appear on an average at the following periods:—

Two central cutting teeth, ...	7th month.
Two side, ,, ,, ...	9th ,,
First back tooth, ...	12th ,,
Eye-teeth, ...	18th ,,
Second back teeth, ...	24th ,,

The first teeth of the lower jaw appear earlier than those of the upper jaw. While the above table gives the average dates, the period varies greatly. Thus the central teeth of the lower jaw may appear as early as the third month, and an interval of some months may then elapse before others are cut. There are cases on record of children being born with some teeth already cut. On the other hand, in some cases the teeth are unusually late of appearing, some remarkable cases being on record of children who cut no teeth till some years after birth. As a rule, if the cutting of the teeth is long delayed, it is an indication of some backwardness of development. It may be due to the child not getting food of a proper quality to supply the needed material for tooth formation, and the slowness of the growth of the teeth may coincide with slowness and softness of bone formation. Parents in such cases should consider whether the child is receiving a sufficiently nourishing diet, and especially should be assured that the diet is not too exclusively of a starchy kind, too much corn-flour, rice, arrowroot, or kindred food, and too little milk, and whether some addition of beef-tea, broth, eggs, &c., should not be made to its diet.

The teeth are already in their sockets in the jaw when the child is born. It is their continuing growth that causes them to press upwards on the gum till they cut through it. While the milk-teeth are pushing their way upwards the foundations of the permanent set are already being laid in the jaws, and when, at the age of two years or two and a half years, all the milk-

teeth are visible, considerable advances have been made in the development of the second set. It is the continued upward growth of the teeth of the permanent set which causes them to press on the roots of those of the milk set. This pressure gradually causes wasting of the roots of the milk-teeth, till, at six years of age, when the first of the permanent set appears above the gum (see pp. 136 and 137), little of some of the milk-teeth is left but the crown attached to the gum, and it usually drops out as the permanent one pushes up to take its place. But at this time, six years of age, the child has not only the twenty milk-teeth, but more deeply in the jaw it has also, already well developed, twenty-eight of the thirty-two that form the permanent set. At this time, therefore, the child has no less than forty-eight teeth in its jaws.

The period of teething is the time when the advancing teeth are pushing up vigorously under the gum, and when the gum is rendered sensitive and painful by the pressure. The pressure is also irritating to other parts, and the excitement carried to the salivary glands (p. 137) by nervous communication causes the constant flow of saliva. The period of teething is, consequently, a time when the child is more than usually irritable and excitable, and more than usually liable to disturbance of various kinds. While this is so, it is too common to blame teething for all sorts of ailments that have little connection with it, and consequently to neglect attending to some of them, or seeking advice for them, in the hope that when the teeth are cut the ailment will pass away. It is the writer's constant experience that, if the mother or nurse will give a little more than ordinary care to the tending and management of the child, and will watch the condition of the bowels, giving, when it seems necessary, a small amount of gently opening medicine, castor-oil or magnesia, and plenty of careful exercise and fresh air, the troubles of teething will cease to alarm and annoy. The various ailments apt to arise during teething and the method of dealing with them, are considered further on in this section. During the period the child is much comforted, and the process of cutting aided, by having a clean india-rubber ring to press and chew with its gums. As a rule lancing the gums is to be avoided.

For the preservation of the permanent teeth children should be trained to use a tooth-brush with warm water daily, using also if need be a tooth-powder of a fine kind. In order to get the child trained to this habit, it is well to teach it to use a brush, even for the milk teeth. A child of two years and a half is quite capable of being trained to a cleanly habit of this sort, and looks upon it as an amusement rather than as an irksome task.

Bathing, Clothing, and Exercise.—The directions already given about bathing infants should be carried out with older children. About six months of age, sluicing with water, which is just tepid, with the morning bath may be given. That is to say, the bath-tub may be filled with water of a moderate warmth, but the child is rapidly sponged with water less warm. Thereafter the drying should be thorough and accompanied by gentle but firm rubbing. If the child seems to feel the cold too much, the colder water should be abandoned for a time. When children become old enough to stand in the bath for the morning cleansing, the water in which they stand should be warm, and tepid water used with a sponge. Children who are able to stand and run about should not be allowed to scamper over the nursery while the bath is being prepared. The body becomes chilled in this way and is unable to stand the cold bath well. The child should be rapidly bathed just out of bed while it is still in full warmth, able to bear the cold and to induce reaction afterwards. At the same time, if it has been unduly warm and sweating in bed, time must be given for it to cool down in bed before being taken to the bath. After bathing the children should be quickly dressed before a fire and then allowed to run about. The evening bath should be always warmer than that of the morning, and from it the child should be put straight to bed. If the practice of the morning cool bath is kept up, then as the child grows it will be so accustomed to it that it will be desired and continued.

Clothing.—Regarding clothing it is only necessary to repeat the objections stated on p. 442 to low-necked short-sleeved dresses, and to socks so short that they do not protect the legs. The dress should fit well, though easily, round the neck, and should always have sleeves to cover the arms. Colds and chest complaints are too frequently due to the half-naked way in which mothers like to see their children's shoulders and arms. If socks are worn, gaiters should be added to protect the legs. When stockings are used, they should never be secured by garters at the knee, for these restrict the circulation and are hurtful; suspenders are the proper means of keeping them up. The same is true of gaiters. Shoes should be as soft and

pliable as possible. Specially while in the house should stiff shoes and boots be removed. They prevent free growth of the muscles of the feet and hinder vigorous and elastic movements.

Exercise.—Up to the age of nine months or thereby a child's exercise is obtained mostly in its nurse's arms, or lying kicking in her lap or in its cot. About nine or ten months, however, the child begins to attempt crawling. If the floor be covered by a warm rug or carpet this is well, but care should be taken that draughts do not sweep across the floor. From crawling it will take to getting on its feet by the aid of a chair and so on till it essays to walk. A mother should let her child go through all the stages at its own sweet will. It will gradually learn itself to use its legs, will become slowly accustomed to maintain the erect position, and thus the muscles are gradually trained to their full use. This is better than setting a child up on its legs and trying to force it into erect ways of moving. If a child is more than usually heavy, its own weight may be too great for the still soft and yielding bones to bear, and the child is often disinclined to attempt standing up straight. It prefers crawling, and it is right, and ought to be allowed to choose its own way.

When children are old enough to walk out and themselves take exercise in the open air, it is best, if there is an open space for it, to let them do so by engaging in some simple game, rather than by dawdling along holding on by the skirts of a nurse. It is free active exercise of arms as well as legs, and of chest muscles too, that a child needs.

During some part of the middle portion of the day the child should have a mid-day sleep, even when it has reached the third or fourth year. In summer the warmest part of the day is best for this purpose, and the room should be cool and darkened, the child being lightly covered. The time of exercise would thus be in the morning before the heat becomes great or in the afternoon, but before it becomes too cool in the evening. In winter the time of the daily sleep needs some alteration to permit the child being out while it is warmest and sunniest.

Children's Apartments.—In houses where the accommodation is sufficient it is well to have a day and a night nursery. Both should be of a moderate size, cheerful and airy, fitted with a fire-place, protected by a guard so efficient that the child can neither crawl through between its bars nor over its top. The ventilation should be well attended to, and should be secured either by a valve ventilator near the roof communicating with the chimney, or by one of the *topmost* panes of the window being perforated, the openings being capable of partial closure. Heated air always rises, and thus impure air, warm from the lungs, rises towards the ceiling and should be allowed a way of escape as high as possible. The arrangement should be such as to avoid draughts. One good method is to raise the lower sash of the windows by a 3-inch board fixed to the sill and on which the sash rests. A space is thus left between the lower and upper sash through which fresh air enters, but it is directed upwards. If possible, the room should not be next door to a bath-room or water-closet; and it should not be in a sunk flat. The windows should be guarded by rods. The rooms should be heated by fires, and not by hot-air pipes or gas-stoves; the communication between the grate and the chimney should never be closed. It ensures ventilation of some kind when open. As soon as the children leave the night nursery in the morning, the windows should be thrown open to let the room be well ventilated; and similarly whenever the opportunity exists by the room being empty, the day nursery should be aired. Further, a nursery should be kept scrupulously clean; all discharges should be quickly removed, as well as dirty linen. No cooking should be done in it, and drying of clothes before the fire should be forbidden. In houses where the accommodation is not sufficient to allow of even one room being used as a nursery, the benefit of the children should be considered, and the principles indicated carried out as far as possible in the other apartments.

THE MANAGEMENT OF CHILDREN IN DISEASE.

GENERAL SIGNS OF DISEASE IN CHILDREN.

Much may be learned as to the state of health of a person by examining the face, eyes, mouth, and various parts of the body; but in dealing with children, who cannot express their feelings, this examination becomes of very great importance. It is possible from it not only to tell whether a child is well or ill, but often also, if ill, what is the character of the ailment and situation of the disease. The information is to be obtained from observing (1) the colour of the skin, face, eyes, lips, (2) the expression of the face and eyes, (3) the state of the mouth and teeth, (4) the gesture and attitude, (5) the movements of the chest, (6) the movements of the

belly, (7) the general state and warmth of the body, (8) the cry of the child, (9) the character of the stools, and (10) the nature of the sleep.

What should be looked for in each of these respects will be briefly indicated.

1. The Colour of the Skin, Face, Eyes, and Lips.—The transparent rosy tint of the skin of the healthy child may be replaced by a general *yellow* colour, seen not only over the whole skin, but also in the white of the eye, indicating jaundice, *i.e.* some affection of the *liver*. A form of jaundice is not uncommon in newly-born children (see p. 459). The skin may be dusky, the lips being bluish, and the same duskiness showing strongly under the finger and toe nails. This is associated with a peculiar condition of the *heart* (see Blue Disease, p. 458). In affections of the *lungs*, where the breathing is seriously impeded, a similar alteration of colour affects the face and lips. Serious disease of the *stomach or bowels* produces a *dull, sallow, or leaden* hue of the face.

(2) Expression and Features.—The most remarkable and sudden alteration of features is seen in diseases of some part of *the bowel*, where the face is pinched and furrowed, and becomes rapidly emaciated, sunken, and lustreless. The rapid movements of the nostrils, accompanying laboured breathing, is a sign of *affection of the lungs*. Hacks and fissures about the corners of the mouth, sunken bridge of the nose, and a general withered and old-mannish look, are frequent in a disease of the blood called syphilis (p. 422). A large head, with prominent overarching forehead, and small development of the face, is the well-known characteristic of a chronic form of *brain disorder*—water-in-the-head—(p. 101). In the early stage of this trouble the child is drowsy, dull, and listless, however lively and active it may naturally have been. The eyes should be observed as to the way in which they close, the complete or incomplete way in which the eyelids meet, the presence of squinting; and the pupil should be watched to note whether it responds to light—becoming small rapidly when light is directed on the eyes, and again expanding when the light is withdrawn. A wide and fixed pupil is almost certainly a sign of serious *nervous disturbance*.

(3) Mouth and Teeth.—The points to notice here are the heat and state of moisture of the mouth, the condition of the gums, the number of the teeth cut or near to cutting, the softness or dryness of the tongue, its colour and cleanness. In teething, of course, the mouth is hot and perhaps dripping with saliva, and the gums may be swollen, tender, and florid. A white tongue points to disorder about the *stomach*. A brown dry tongue is the state in fever of the typhoid type. The tongue is also frequently covered with patches of a white vegetable growth (Thrush, p. 460). The inside of the lips and cheeks are to be inspected for the presence of small ulcers.

(4) Gesture and Attitude.—Note here the movements of the hands and arms. Children, like grown-up people, often try to aid obstructed breathing by grasping with the hands and raising the arms to help expansion of the chest. In severe *fevers* the rigid bend of the fingers with the thumb doubled in on the palm is very noticeable. In irritation of the *bowels* the thighs are bent up on the belly while the pain lasts. The involuntary movements and twitches of *St. Vitus' Dance* (p. 125) are well known.

(5) Movements of the Chest.—Rapid and jerky movements, with constriction at the sides, and accompanied by heaving of the belly, and depression at the collar-bones, indicate serious *lung* mischief. Breathing that is accompanied by a pleuritic stitch is manifested by the sudden convulsive stop in the middle of the inspiration, the pain being also shown by the movements of the face and the cry. Disease of the *belly* also affects the movements of the chest, for if movement of the belly causes pain it will be kept quiet, and all the breathing will be performed by chest movements, which will be short and quick, incomplete, that is to say, prevented from going so far as to exert downward pressure on the belly.

(6) Movement of the Belly.—As indicated above, the movements of the belly may be exaggerated, when the disease is in the chest, to relieve the chest of the work it is unable to perform, or the movements of the belly may be entirely restrained when it is itself the seat of disease. In the latter case it will be tense, the muscles firmly contracted to guard against movement, and the thighs will be bent up on it to relieve it of strain. When the belly is the seat of pain, specially colicky pain due to flatulence, the contracted muscles make the belly feel tight and firm, and the child usually kicks and twists itself about, crying lustily while the pain lasts. But as soon as the spasm of pain has passed the child speedily quiets down, giving vent only to a final sob or two, unless another attack rouses it to the same crying and kicking. On the other hand, if the pain is inflammatory the child lies moving as little as possible, for movement

increases this pain, and there is moaning rather than crying out.

(7) **The General State and Warmth of the Body** may be gathered from noticing the plumpness or wasted appearance, firmness or softness of the child. The way in which the child holds itself together, also, should be observed, whether bright and buoyant, or languid and drooping. The heat of the body is roughly ascertained by laying the hand on the skin or on the head; but the most reliable means is by using the thermometer (p. 10). It will indicate a rise of temperature amounting to fever when feeling with the hand would give no hint of anything wrong. A mother who learned how to use it, and it is very easy learning its use, would find it of inestimable value. It would not only tell her whether her child was really ill, but also within an hour or two of the employment of her simple method of treatment she would be able to tell by means of it whether any good had been done.

(8) The **cry** of the child is often peculiar. The feeble, plaintive cry is itself sufficiently suggestive. An acute cry, very strong and intermittent, is not infrequent in "water in the head" (p. 101), while a hoarse, muffled cry is heard in croup (p. 417). If a child, apparently healthy, takes suddenly to a constant crying, which movement and dandling seem only to aggravate, thorough search should immediately be made to see that it is not due to some wayward pin, or some uncomfortable fastening or knotting of the dress.

(9) The character of the **stools**, &c., give important indications of the state of the health. In the case of the infant they should be two in number daily, lightish yellow in colour, soft, and not offensive in smell. If they are not so frequent as usual, or more frequent, dark or green coloured, too liquid, or curdy and offensive, something is not quite right, which some slight alteration in the diet, in quantity or quality, or both, may set right even without medicine. (Refer to page 446.)

(10) The **sleep** of children is disturbed during illness. A restless disturbed sleep, from which the child often starts up with a cry, should always call attention to the child's state of health. It may be only some error in diet that is the cause. If so, this will be indicated by the state of the stools. Perhaps the child has had no motion the previous day. Let inquiry be made, and opening medicine given if necessary. Disturbance in the bowels due to worms is a frequent cause of this restlessness (p. 463). On the other hand, an undue drowsiness, languor, and listlessness are not to be neglected, specially in children between two and seven years of age. These are among the early signs of brain disease.

GENERAL TREATMENT OF CHILDREN IN DISEASE.

When a child is suspected or seen to be unwell there are certain steps that ought to be taken at once, no matter what may be the nature of the illness, steps which, if taken immediately, will, in many cases, be able to convert into a short and slight illness what, if neglected, might become a long and serious one, and which may even be sufficient to arrest the illness altogether. As soon as the child is supposed to be ill it should be stripped, bathed, and put to bed, if possible in a quiet room, not in a noisy, much-frequented apartment. The bed should be fresh and clean, not closed in, and freed entirely from hangings and curtains. *The room should be well ventilated, but free from draughts.* A fire secures a continuous supply of good air to a considerable extent, besides warming the room, which should be kept as much as possible at a regular temperature—a moderate one (62° Fahrenheit)—which is most easily managed by the aid of a thermometer kept hanging in the room. At once attention is to be directed to (1) the diet of the child and (2) the state of the bowels. (1) The whole trouble may have arisen from overfeeding or improper feeding. The child is, therefore, to be put on milk diet mainly, to which, if its age warrants it, light beef-tea or broth (strained) may be added (see the directions given under MANAGEMENT OF CHILDREN, p. 449). The quantity is to be kept strictly moderate, small quantities given in frequent but regular intervals being better than large quantities at one time. Irregular feeding must be avoided, and no solid animal food whatever given. (2) If the bowels have not been properly moved for some time a moderate dose of castor-oil or of fluid magnesia, or similar mild purgative, may be given. This is, generally speaking, all that should be done on the mother's or nurse's sole responsibility, when the services of a medical man are at all obtainable. When such services can be obtained they should be at once sent for, as very slight symptoms may be the forerunners of very serious disease. The medical man being in attendance his advice, *and none other*, should be strictly, promptly, and conscientiously followed.

But it will often happen that medical aid is not within immediate reach; that, owing to distance or some other case, it may be many hours before the doctor can arrive. Meanwhile the child seems highly fevered, is very restless in its sleep, seems to be wandering, or the mother fears convulsions. What is to be done? This, at any rate, must not be done: the mother or nurse must not seek to quiet the child by "soothing syrups" of any description. Especially in nervous conditions is a great deal of harm possible by their means. There are, however, two things the mother may do without the least fear, two things beside what has been already advised. First an injection into the bowel should be given for the purpose of producing at once a full clearing out of the lower bowel. The fact that castor-oil or some other opening medicine has been already given does not stand in the way of the injection, if it seems needed, for the injection will clear out the lower part of the bowel, while the medicine sweeps everything down from the upper end.

Mode of Injection.—An enema-syringe should be used (see plate of Nursery Appliances). It is an oval elastic bag, with an opening at each end of the oval; from each opening proceeds an elastic tube. One tube ends in a long ivory nozzle for insertion into the bowel. The other end dips into a bowl of water. When the bag is compressed by the hand anything it contains is forced out through the nozzle; when it is allowed to expand it sucks up a fresh supply of water by the other tube, the movement of the water being directed by valves. Take a small bowl of tepid water, work the syringe for a little time till it is found to be in good working order, expelling a steady stream of water, unmixed with air, from the nozzle with each compression of the bag. Now oil the nozzle, and by a twisting movement gently pass it up into the child's bowel, using no force, and directing the point slightly backwards and to the left, the child lying on its left side in bed or in the nurse's lap. An ivory plate prevents it being pushed too far. Then gently but steadily squeeze the bag till the water has all passed into the bowel, then relax and let it refill, gently press again. *Take care that all the time the other tube —the inlet tube—is dipping below the surface of the water in the bowl, so that no air is sucked in.* Even in the case of quite a young child the quantity injected by two or three compressions of the bag is not too much, when it is desired to act well and quickly. With older children a small bowlful of water may be injected with perfect safety. Besides plain water, soapy water and salt and water are often used, one table-spoonful of salt to half a pint of water. The salt and water act quickly and energetically. When an enema-syringe cannot be obtained, a brass one with ivory point may be used. Glass syringes are rather to be avoided, and, if used, great care must be taken that the point is quite round and not sharp, and that it is not broken in the bowel.

The second thing that may be done for a child threatened with some illness that looks serious is to give it a special warm bath or wrap it in a warm pack.

To give **the warm bath** the water should be at a temperature of 98° Fahr., and it is best to test the heat by the thermometer rather than by feeling with the hand. The child should be set in the bath up to the neck, and a blanket fastened round the neck of the child, and sweeping round the sides of the bath should completely envelop bath and child. The child should remain in the bath for twenty minutes to half an hour, the heat being all the time maintained by frequent additions of warm water round the sides. The child may then be lifted up, rolled in the blanket already round its neck, and without any drying put into bed. After another hour, or even less if the child finds the blanket too disagreeable to let it rest, the child should be rapidly rubbed down, clothed in a warm flannel gown and carefully wrapped in the bed-clothes. Or the child may at once, on being lifted from the bath, be rubbed down, clothed in flannel and put to bed.

The warm pack.—The child is to be stripped naked and rolled in a half-sheet or half-blanket wrung lightly out of warm water. It should be kept so for an hour and then rubbed down, and its flannel night-gown put on. Young children grow restless by being imprisoned in the wet sheet. They are usually quiet if their arms are allowed out.

The benefit of the warm bath is that it brings the blood to the skin, it causes the blood-vessels of the skin to relax. They become able to contain more blood in consequence, and thus deeper parts are relieved of too great a quantity of blood. At the same time, if there is fever, the water used being of a considerably less degree of heat than the blood, heat is withdrawn from the body, and that has a soothing effect on the nervous system. If, as has been advised, an injection has previously been given and has produced free evacuations, the unloading of the bowels will have already acted in a similar way.

The blood will have been diverted from the head and central nervous system, and the calming effect of the bath or hot pack will be all the more perceptible because of this previous action.

Now these two methods of treatment of children are simple in the extreme, and if carried out with a moderate degree of intelligence are incapable of doing harm. They will often dispel from the child within a short time all the more alarming symptoms, and secure for it some quiet rest and sleep. Often a child, that late in the evening shows signs of some serious illness, if treated in this way, and if care is given to the diet, &c., as already directed, will appear perfectly well in the morning. Even if not, and even if the illness does go on, the child is in a much more favourable condition in relation to the future course of the illness than it would have been.

AFFECTIONS OF THE NEWLY-BORN CHILD.

Irregularities of Form in the Newly-born.

An **irregularly shaped head** is not infrequent as the result of severe labour, or the use of instruments, &c. It is frequently extremely elongated, perhaps badly flattened or pressed in at one side. No fear is to be entertained on this account. Within a few days the head will gradually return to the normal shape.

Tumours or swellings may exist on the back of the head or at other parts of the head. **Spina Bifida** is the name given to a tumour occurring at the lower end of the backbone, due to an arrest of the growth of the bone, and protrusion of the membranes and other parts of the spinal cord in the shape of a bag. It is in many cases amenable to skilled treatment. Such swellings must not be interfered with by the mother or nurse. They are carefully to be guarded from injury or pressure. Spina bifida is much less serious than the similar condition of the head, and children born with it may be otherwise well-formed and healthy. A pad should be carefully adjusted and fixed over the swelling so as to maintain all over it a moderate degree of pressure.

Defects in the Opening of the Bowel or Urinary Passages sometimes exist. They should at once be brought under the notice of the medical attendant.

Hare-lip.—Hare-lip or split-lip occurs on the upper lip, the split being on one side of the middle line or the other, or on both sides. It is due to an arrest of development. For the upper jaw is formed by parts from each side growing inwards towards the middle line. They do not meet in the middle, but in the gap left growth takes place of an intermediate part which in time unites completely with the parts on each side, and thus the complete upper jaw is formed. This intermediate part it is which in the developed condition carries the four front teeth. Now hare-lip is an arrest of the growth at one period or another, the result of which is that complete union is not effected at one or other side or at both. The split may involve the soft parts only, or it may extend through to the bone. In the most extreme cases the central part of the upper jaw, including the bone and soft parts connected with it, is quite ununited with the rest of the upper jaw at each side. Often this central portion is projected forwards and upwards, standing straight out from the face, and sometimes it is so much twisted to one side as to block one nostril, out of which it seems to be sticking. In such cases the palate is cleft also, that is, the roof of the mouth is deficient in the middle line, owing to an arrest in the development of the bone, which should have grown forward till junction and complete union was effected in the middle line.

Cleft-palate in slight cases only involves the soft parts at the back of the mouth, the uvula, &c. (Fig. 136, p. 263). As it extends forward it involves the bone, till in extreme cases the cleft passes from back to front. There is thus no separation between the cavities of the mouth and nostrils.

When hare-lip exists alone, bone union being complete, the deformity is the only thing, and it can easily be remedied by an operation, which will leave little or no hint of the original condition. But when it is associated with non-union of the bone it interferes with suckling. This may sometimes be remedied by the mother using a nipple shield with a large nipple. When, however, the split is large and cleft-palate also exists, suckling is impossible, and even feeding is very difficult. Cleft-palate may exist alone to a greater or less extent. In many cases it is not noticeable till the child begins to speak, and then it is recognized by the peculiar nasal "twang." Both conditions can be remedied by operations. For hare-lip the operation should be performed before teething. It is not attended by danger, and its results in improving the appearance are remarkable. For cleft-palate there

is no haste, but it should not be delayed till the child has learned to speak and has acquired the "twang." It is not nearly so simple an operation as the former. In extreme cases the separation may be too great to permit of closure by operation, but a plate may be made to cover the opening.

Blue Disease (*Cyanosis*) is due to an arrest of development interfering with proper aeration of the blood. While the child is still in the womb its own lungs are inactive and unexpanded. The aeration of the blood of the child is effected indirectly through the blood of the mother. The blood of the child passes in the vessels of the cord to the placenta, which connects the child to the mother, and is there purified by exchanges with the blood of the mother. Returning from the placenta the blood of the child passes to the upper chamber of the right side of the heart, partly directly and partly through the liver. In the adult the right and left sides of the heart are separated by a complete partition, but in the fœtus an opening exists through which the pure blood can pass directly through the right upper chamber to the left, and from the left side it is then distributed through the body. After birth this opening should close, and then the blood requires to pass from the right side through the lungs, where it is purified, before it reaches the left. In rare cases this opening remains unclosed, and thus while part of the blood passes through the lungs to the left side, part escapes directly from right to left without previously passing through the lungs, and thus without aeration. The blood is, therefore, constantly deficient in oxygen, and the blueness arises in consequence. The child's skin, its cheeks, lips, hands, and feet are markedly livid, the fingers and toes are clubbed and the nails are incurved. It breathes rapidly and is liable to attacks of breathlessness. In marked cases death usually occurs in a few days, in slighter cases life may be prolonged for some years. All that can be done is to keep the child quiet and to protect from cold.

Tongue-tied. — This condition is due to shortening of the bridle of the tongue. When it is present the child cannot push the tongue out over the lips; and it interferes with the suckling. It is easily set right by turning up the tongue and dividing the front of the bridle by means of a blunt-pointed pair of scissors. This should only be done by a medical man, for if the scissors be directed upwards one of the blood-vessels running along the under surface of the tongue may be injured.

Cataract. — Children are sometimes born with white spots in the lens of the eye, interfering with sight, or the whole lens may be white, rendering seeing impossible. This is due to some defect of nourishment in the womb. The child should be taken early to an oculist, as an operation is frequently necessary very early to prevent changes arising in the eye that would interfere with the usefulness of an operation at a later period. (See p. 374.)

Diseases of the Newly-born.

Ulceration or Bleeding at the Navel.— If the bleeding be from the attached piece of cord it should be tied a second time nearer the belly. This may occur some hours after birth because the cord has been improperly tied. The clothing should be immediately undone and the cord tied again between the former place and the belly. Four or six strands of linen thread form the best material for the purpose. It may also occur owing to the remains of the cord being too early separated. If so, the bleeding is best stopped by gentle steady pressure with the finger or a small pad. It should not be allowed to continue, else the slow drain may be very hurtful. If the part be not healing properly, it should be carefully sponged frequently, and if necessary may be painted with an astringent like syrup of tannin, or tannate of glycerine.

Inflammation of the Eyes.—One form of inflammation of the eyes of a newly-born child, if not watched with great care, may ruin the child's eyes in the course of a few days, and render the infant incurably blind. It begins usually about the third or fourth day after birth. The eyelashes stick together, and the borders of the lids are red and crusted. Both eyes are attacked, the one after the other. The lids become swollen, and in a day or two thin fluid pours out of the eyes, the fluid in about a week has changed to matter, with which the eyes are constantly overflowing. The treatment consists in keeping the eyes scrupulously and constantly clean. Use warm water, and a soft rag or lint: *open the eyes thoroughly, turning out the lids, and cleaning away every particle of matter.* To the warm water a few drops of Condy's fluid, sufficient to make the water slightly pink, may be added. *This must be done*

not once nor twice daily but very often, so that no matter is allowed to accumulate in the eye. No ointments should be used. The inflammation, however, is of so dangerous a character in its effects upon the sight, that no time should be lost in having proper medical treatment.

Jaundice.—This is not uncommon during the first or second week of infant life, the skin and white of the eyes becoming quite yellow, and the stools colourless. It is not to be feared. Usually no remedies are required. It will pass off often as quickly as it came. If excessive give a small dose of castor-oil only.

Swelling of the Breasts.—This is not infrequent in newly-born children. The breasts are firm and tense, and occasionally fluid like milk oozes from them. *They should not be squeezed or pressed in any way.* Gentle rubbing with warm oil is often all that is necessary. Where redness or a purplish tinge indicates a more severe form of swelling, a soothing poultice of warm bread and water should be applied, or a warm sponge held on them each time the child is bathed.

Retention of Urine and Stools.—This may be caused by some defect already alluded to (p. 457). The nurse is never, by any means, to give "nitre" in the hope of causing the child to make water. She may use a warm bath, or place warm cloths over the lower part of the belly, and that usually will be sufficient. The attention of the medical attendant should be directed to the child if this is insufficient.

Moles and Mother's Marks.—These have been sufficiently considered on pages 247 and 322.

DISEASES COMMON TO CHILDHOOD.

Ailments at the Periods of Teething and Weaning.

The period of teething is undoubtedly a time when the child is easily upset, restless and highly excitable, and, therefore, more liable to ailments than at other times. But it is quite certain that to the teething process is attributed all sorts of trouble, due rather to careless nursing and bad management. In some cases the child is dosed with medicines of one kind or another, in other cases the excuse, "Oh! it is just the teeth," is given for every disturbance of health; and without much further thought the mother or nurse waits on time to remedy the ailment, when the teeth will all have been cut. Both methods are mistaken. It is not to be forgotten that the child is at a stage of development when it is in a peculiarly sensitive condition, but just for this reason more watchful care is to be exercised, and while medicines are avoided more attention is to be paid to good management. Disturbances of stomach and bowels are common, looseness of bowels especially. These are to be met by careful nursing and dieting, as indicated on p. 460. The same careful management will diminish the restlessness and excitability of the child. If, however, the bowels being free and regular, the child is much disturbed, mothers often feel they must give something to calm and soothe. Again it is necessary to repeat the warning against so-called soothing syrups, given on p. 447. One drug, however, may be given to calm the nervous system, and it is devoid of danger. It is bromide of potassium. Let 32 grains be dissolved in a little water and made up to one ounce, that is eight tea-spoonfuls, with simple syrup. Of this a tea-spoonful is given occasionally, but not frequently repeated. Lancing the gums, so often resorted to, is as a rule a barbarous practice, and is never done by modern physicians, unless the gum over the coming tooth is distinctly red and angry looking, and the tooth near the surface.

Inflammation of the gums does justify the procedure, and is greatly relieved by it, and that even though the tooth be not yet near the surface. The inflammation is readily known by the swollen state of the gum, and its dark-red appearance. In such a case, when the tooth is yet deep in the gum, the lance should be applied to the side and not over the coming tooth. For if the wound heal before the tooth is cut the scar is likely to make the cutting of the tooth more difficult.

At the period of weaning disorder of stomach and bowels is frequent. This difficulty may also be overcome by management. If the child's bowels are very troublesome, the mother had better delay the process for a little and then try again, or effect it very slowly.

Coughs, Colds, and Affections of the Chest.

Cold may take the form of running at the nose—**snuffles**—(preceded by frequent sneezing), watery eyes, some degree of feverishness, and the child is cross. This is a form of what is called "catarrh," from two Greek words

meaning "a running down" (see p. 154). It may extend from the nose to the throat, causing it to become red and swollen, may pass down into the windpipe, and may also cause a similar condition in the stomach, called catarrh of the stomach. In these severer forms there will be loss of appetite, white tongue, and if the child can speak it may complain of headache and pains in the back or limbs. Whether the attack be mild or severe, simple treatment is all that is required, that is, give the child a warm bath, keep it warm in bed, give gentle opening medicine—castor-oil—at once, let it be fed on slops, and give thrice or so daily 5 to 10 drops ipecacuanha wine. If the nose is very much obstructed some relief may be given by laying over it a sponge squeezed out of hot water. This is all the treatment that should be adopted without medical advice. This affection may, however, go on, the lungs may become affected and bronchitis or other disease of the chest result.

Bronchitis (p. 270).—This will be attended with quick, hurried breathing, with flushed face, and other aggravated signs. The ear applied to some part of the chest may detect wheezing or piping sounds. These are too serious forms of disease to be delayed over, and medical aid should speedily be secured. The treament advised on p. 271 may be adopted for children to the extent of applying a hot poultice occasionally to the affected side of the chest, and using the bronchitis-kettle, a constant stream of steam being poured in the neighbourhood of the child's cot.

Cough is present in most of the above affections, and is to be treated as described for cold. But, not infrequently, especially when the back part of the throat is evidently red and congested, the cough may be very irritating and even suffocative. This is often relieved, in addition to the means already mentioned, by putting a small, mild, hot poultice on the front of the neck, just over "Adam's apple," and giving repeated small doses of ipecacuanha wine, and if necessary by using the steam from a kettle as noted above.

There is a cough, however, which should rouse instant intention, a hoarse muffled cough "like the distant bark of a puppy," or a cough with a ringing metallic sound—a brassy cough. Let the mother or nurse be on guard against croup, of which this is strongly suspicious. (See p. 418.)

Affections of the Mouth, Stomach, and Bowels.

Thrush.—In this disease the tongue and inside of the mouth are covered by white patches of a peculiar growth, sometimes forming a continuous white crust. It is often accompanied by disordered stomach and bowels, particularly if the child be weakly. The patches are really due to the growth of a minute microscopic plant, flourishing because of the unhealthy state of the digestive canal.

Treatment. (1) Give mild opening medicine—magnesia with a little rhubarb. (2) Correct at once any errors in diet. (3) Apply to the mouth borax and honey, or glycerine with an equal part of solution of borax, or chlorate of potash (20 to 30 grains of either to an ounce of water). The disease will not be properly cured unless the disordered stomach is set right by proper dieting.

Ulcers on Lips and different parts of the mouth occur readily in children whose stomach and bowels are in bad condition. Treatment is the same as for thrush.

Inflammation of the Mouth of an extremely serious kind is seen in weakly, ill-fed children, living in large towns, in badly-aired apartments. It frequently follows on measles or other weakening disease. It begins as an ulcer, of a dirty ash-gray colour, on the lip or inside of the cheek, and eats its way into the cheek and gums. The face is swollen, saliva dribbles from the mouth, the breath is foul-smelling, and the teeth may drop out. The pulse fails, the stomach and bowels become disordered, and death results, often very rapidly, from exhaustion.

Treatment requires first of all to be directed to cleanse the stomach and bowels by a dose of rhubarb and magnesia. Nourishing food must be freely supplied, but in small quantities given often, milk and beef-tea specially. Wine is frequently needed to combat the feebleness. A mixture of chlorate of potash, 60 grains, syrup, 1 ounce, and water, 3 ounces, should be obtained, of which one to two tea-spoonfuls should be given every four hours. The mouth should be bathed with a solution of 30 grains chlorate of potash to 1 ounce of water.

Derangements of the Stomach and Bowels.—These are oftenest due to improper feeding; they also are frequent at periods like teething, weaning, and so on. They may be due to excessive quantity of the milk or altered

quality. If the child be at the breast it may have been too frequently suckled, or owing to some condition of the mother, or some improper food taken by her, the quality of her milk has been changed. This can be easily remedied. If the child is not at the breast the quantity and kind of food it is getting must be seen to. Similarly too sudden weaning, or irritation due to teething, may be the cause. If the cause can be discovered let it be removed at once, and probably, without further steps, but simply under the influence of proper food, given at proper intervals and in the right quantity, the child will be restored.

Vomiting is one sign of stomach derangement. If the child vomits the milk, unchanged, soon after taking it, and is immediately well and cheerful, *it has had too much.* Therefore let the quantity and frequency of suckling be diminished. Or if the child vomits frequently and looks pale and exhausted, is fretful and whining, and never easy unless when at the breast, sucking greedily and never satisfied, here again there is indigestion, caused also probably by improper dieting. If regulating the feeding in the ordinary way (p. 441) does not allay the irritability of the stomach, stop altogether giving the ordinary quantities, and give very small quantities of milk—one or two tea-spoonfuls—at intervals of twenty minutes or half an hour, for a considerable number of hours, or till the vomiting ceases. Then gradually increase the quantity and lengthen the intervals, till ordinary quantities are given every three or four hours. A warm poultice over the stomach will also help. Vomiting, persistent no matter what or how little is taken, occurs in disorder of the stomach from cold. If the plan already advised, one or two tea-spoonfuls at a time and at brief intervals, and warm applications over the belly, does not arrest it, then let some ice be obtained. A few pieces should be put into a glass of fresh milk, and the whole allowed to stand till the milk is ice-cold. Of this give the child a tea-spoonful, or at the most two every half-hour or so, and apply warmth outside. After the lapse of some hours give the iced milk less frequently, and give one or two tea-spoonfuls of ordinary milk between the doses. The irritability will almost certainly yield to this method, and gradually larger quantities of ordinary milk at longer intervals may be given. *It is needful to avoid giving any considerable quantity of the iced milk at a time, for that would be hurtful.*

Colic and Flatulence are manifested by the infant suddenly becoming fretful. It draws up its legs towards the belly and cries for a time, and then returns to its usual state. This is repeated on another attack. The distress may be great and the pain long, shown by the long-continued screaming and violent movements of the legs, and it may be relieved by a discharge of wind or stools. Here, again, look to the food the child is receiving. Get rid of any irritating matter by giving a dose of castor-oil, after which magnesia in doses of 3 to 5 grains, or fluid magnesia, one to two dessert-spoonfuls, may be given occasionally if required. When the colic is present rubbing the belly with the warm hand, or applying hot cloths will relieve it. The only other remedy that the mother or nurse should use is dill-water, of which half to one tea-spoonful is sufficient, or essence of anise, 5 drops on sugar.

Diarrhœa.—This may be of a simple kind in which merely the number of motions is increased. Such looseness is often the result of the irritation of teething, or the result of weaning, and is not to be regarded with alarm, though it is to be watched. Changing the diet entirely will often suffice to stop it. Thus instead of cow's milk give goats' or asses' milk, or condensed milk; or, if this does not succeed, stop milk entirely and give thin arrowroot made with water, weak chicken or mutton broth, &c. Frequently the addition of lime-water to the milk (a table-spoonful or so to a cupful of milk) may check the diarrhœa, or 5 drops of ipecacuanha wine in a tea-spoonful of dill-water every hour or two if the looseness is continuous. *Laudanum should on no account be given by a mother or nurse.* Even a single drop has been the cause of a child's death. As regards beef-tea and broths it is to be noticed that if given strong and in any quantity they rather encourage the looseness. Therefore let them be given weak and in small quantities at a time; and further to check the tendency to increase the looseness it is well to boil the beef-tea or broth with sufficient corn-flour to thicken it slightly. Besides the simple form of diarrhœa there are others in which the motions are greenish, slimy and offensive, and passed with straining, accompanied by great pain and exhaustion, the purging being attended by vomiting.

Looseness due to an inflammatory condition of the digestive tract, an **intestinal catarrh** (see p. 162), is attended by symptoms of this kind.

Infantile cholera or summer diarrhœa of children is also of this description. It usually begins suddenly with vomiting of milk little changed and with the passage from the bowel of greenish-yellow material, flaky, and containing lumps of undigested food. The child is restless, pained, as evidenced by the movements of the legs, and cries for and greedily drinks water. The motions become watery and colourless, and so much fluid is passed from the body in a short time that the child becomes excessively exhausted, with pinched dusky face and hollow eyes. This is a very dangerous kind, for the child may die exhausted in a comparatively short time. No delay in getting medical advice should be suffered in such severe forms. Till this can be got the ordinary diet should be stopped. The child should have plenty of cold water to drink, and should be permitted to suck small pieces of ice. The belly should in all cases be kept warm, and much may be done by rubbing or applying warm cloths, or a hot poultice made of equal parts of mustard and flour should be applied over the belly. At the outset it is well to give a single dose of castor-oil to clear away any irritating material. The following mixture may then be used:—

Aromatic Spirit of Ammonia...quarter of an ounce.
Ipecacuanha Wine................50 drops.
Subnitrate of Bismuth...........24 grains.
Mucilage and Syrup, of each...1 ounce.

Mix, and give a tea-spoonful every two hours as required.

White of egg beat up in water and slightly sweetened may also be given to drink. To meet exhaustion 5 to 15 drops of brandy in water may be given every half-hour or hour as seems necessary. It is exceedingly dangerous to give laudanum in such cases, and as a rule it should be given only by the medical man himself. If, however, the case is urgent, and medical advice not obtainable at the time, *a single drop* may be added to the brandy and water if the child is a year old or nearly so. This may be repeated in two or three hours if deemed necessary, but not a third time without advice. Should the child fall into a natural sleep it is probably a good sign. When the acute stage is passed, milk should be given in small quantities, to which lime-water has been added, and the milk should first be boiled.

Chronic diarrhœa, which occurs between weaning and the end of teething, is best met by the use of raw beef if the changes in diet advised at the beginning of this article are not sufficient. The beef is scraped into a pulp and mixed with salt, sugar, or fruit-jelly, and rolled into little balls or given as a sort of paste. Small quantities are given at first, and gradually increased till a child may take a quarter of a pound of meat so prepared daily. The only drink allowed is white of egg in sweetened water. After a time the ordinary diet may be gradually restored. To avoid the danger of worms the best meat should be obtained.

Intestinal Obstruction as it occurs in children is in the form of **intussusception**, in which one part of the bowel slips into another part, as one part of the finger of a glove may be made to slip into the neighbouring part. It is met with in infancy and early childhood, the male child being more liable to it than the female. It is occasioned by irregular action of the bowels, sometimes set up by improper food, by the presence of worms, or by diarrhœa. It is very liable to be misunderstood, the illness being taken for an attack of colic or diarrhœa, for though proper motions are not passed, a bloody discharge is.

The **symptoms** arise suddenly with very severe pain, readily causing convulsions. Vomiting soon occurs, and the *vomit is often streaked with blood, and in a short time becomes smelling of fæcal matters.* Severe straining at stool is present, and a bloody discharge is passed without proper motions. On examining the belly the mass of obstructed bowel may be detected as a sausage-like swelling. The child may die in a few days of shock or exhaustion.

The **treatment** must be prompt. Vomiting of material from the bowel and the discharge of blood should lead to help being instantly obtained. *Purgative medicines do harm.* The mother or nurse may, by means of an enema syringe, inject into the bowel, slowly and carefully, thin gruel or thin starch. This may be done in large quantity in the hope of releasing the obstruction by filling the bowel, and so causing it to slip up out of its unnatural position.

Costiveness.—It must be noticed that some children are costive by habit, and have motion only once in two or three days. It must also be remembered that frequent dosing with medicine is itself productive of costiveness, and is otherwise injurious. Medicines should therefore be avoided as much as possible, and reliance placed on proper dieting and on training the child to regular habits, to train it to seek relief at, as nearly as possible, the same time every

day, say after breakfast. Changing the diet is often as valuable for costiveness as for diarrhœa. When some form of medicine is necessary castor-oil or manna may be used. A simple treatment is to cut a piece of yellow soap into the shape and half the length of the little finger and push it gently up for 2 or 3 inches into the bowel, and there allow it to remain till it excites the motion. If two or three days have been allowed to pass without the child securing a motion it may be necessary to inject one or two syringe-fuls of tepid water as directed on p. 456. When castor-oil is given for costiveness it is well, instead of giving it now and then, to give a small quantity at the same time each morning for a good number of days, and when the bowels are regular the quantity should be gradually diminished till finally it is stopped altogether.

Worms.—These may often be prevented by the careful avoidance of improper kinds of food, and by proper seasoning of the food with salt. They are often introduced with animal food. Great care should, therefore, be exercised in the thorough cooking of all butcher-meat, especially pork, ham, and sausages. They are of three kinds —(1) Tape-worm passed in pieces like flat white tape, (2) round-worm, and (3) thread-worm. They, and all the symptoms they produce, have been sufficiently described on p. 167 and following pages. It is specially thread-worms that affect children. The best treatment is 1 to 3 grains of santonin given in the morning in cream, and some hours afterwards repeated injections of tepid water, in every half-pint of which a table-spoonful of salt has been dissolved, serve to bring them away. Steel-wine or a tonic of some kind should thereafter be given to the child, as well as good food, as debility favours the presence of worms. For the method of injection see p. 456.

Falling of the Bowel. — This may arise from debility, from diarrhœa, or from costiveness owing to straining. It is to be prevented by getting the child into a proper state of health, relieving the costiveness, or checking the diarrhœa. *The bowel must not be allowed to remain down.* To return it bathe the part gently with cold water, form the fingers into a cone and embracing the part gently push it upwards.

Rupture. — This may occur at the navel within a month or two after the child's birth. It is a swelling which increases with crying or straining. It is caused by a portion of the bowel being forced through the little opening at the navel under the skin. The bowel must be kept within the belly by a small firm pad, secured by a bandage. Rupture in the groin shows a swelling in one or other groin passing downwards and inwards to between the legs. It may exist at birth or be brought on by straining, coughing, or crying. The bowel should be returned at once into the belly, and a proper truss obtained for keeping it constantly in place.

Bed-wetting (*Incontinence of Urine*).—This is a frequent affection, and is due very often to the presence of some irritant in the bowels, such as worms, or about the private parts. Careful search should, therefore, be made for such a cause. Attention should be given to the diet to avoid an irritating quality of the urine. Only simple food should be given, pastries and such things being avoided, and simple drink also, milk or water. Before going to bed each night the child should be set down in a warm salt-water bath, covered with a blanket, for 10 to 20 minutes, and should be roused several times during the night to empty the bladder. It is also recommended that the child should be prevented sleeping on its back by some simple contrivance, such as binding on a thread bobbin. If these measures fail, a doctor should be speedily consulted, lest the habit become confirmed. Mothers should be careful that children are not punished for what may be a weakness rather than a fault. If a doctor is not easily obtainable, let the child get 2 to 4 drops of tincture of belladonna in a little water before going to bed.

Spasmodic and Nervous Diseases.

Convulsions may be due to disordered stomach and bowels, caused, for instance, by too much food, or by improper food (unripe fruit, raw carrots, turnips, &c.). They may be due to teething, constipation, worms; they occur sometimes at the beginning, or during the course, of some diseases, such as scarlet fever, &c., and they are frequent in diseases of the brain, such as "water in the head." They may be slight or severe, from mere twitching of face to those accompanied by staring eyes, distorted features, and violently agitated or rigid limbs. Convulsions are readily caused in children because of the nervous matter of the spinal cord being very excitable in them, owing to the controlling action of the brain being not yet well developed. Any irritation, therefore, conveyed to the spinal cord is readily communicated to nerves passing to various groups of muscles, and a stimulus is

thus quickly conveyed to the muscles causing them to pass into a state of rapid contraction. Now the commonest irritation is that derived from the bowels because of the presence of some undesirable material, improper food, or undigested masses of food for example.

The period of teething is also an age liable to convulsions, not only because of the constant irritation, but also because at the time the child's nervous system is in a highly excitable condition. The treatment is twofold (*a*) during the attack, and (*b*) preventive. (*a*) Loosen the child's clothing: dash cold water in its face, or on the chest. A mere sprinkling of water is of no use: a good quantity should be thrown straight on the child. Immerse the child up to the belly in a warm bath, and apply cold to the head. If the cause is suspected to be in the stomach give a dose of ipecacuanha wine to cause vomiting, from a tea-spoonful upwards according to age: if in the bowels give an injection according to directions given in p. 456. In any case an injection is most valuable. Salt water may be used for the injection, or soap and water, or castor-oil and warm water. (*b*) Correct errors in diet: if the gums are highly inflamed and seem to be the cause, lancing will relieve them. Frequently convulsions indicate very serious brain mischief, and therefore the advisability of at all times consulting a doctor.

Night-terrors, in which a child starts up from sleep shrieking and in a state of extreme terror, are commonly caused by irritation through undigested or indigestible food. Care in the management of food, already so often advised, and attention to the bowels, will prevent their recurrence.

Spasm at the head of the Windpipe—Child-crowing—False Croup.—The child is suddenly seized, and frequently during sleep, with spasm that prevents the entrance of air to the lungs; the face becomes swollen, red, and then bluish, owing to the great difficulty of breathing. The child is extremely agitated, and there seems a tendency to convulsions. In a short time the spasm yields, the air rushes in with a long crowing noise, and the child falls back pale and exhausted, and becomes in a short time composed as if nothing had happened. The fit may recur and may, if prolonged, cause death by suffocation. It is a nervous disease, and occurs owing to nervous irritability. The irritation may be from teething, or the child may be so excitable that a slight fright may occasion it. Use cold water as recommended in convulsions, and allow plenty of fresh air. A hot foot-bath with mustard, or a warm bath for the whole body is also useful. While the child is in the fit, forcibly open the mouth and pull forward the tongue, grasping it by a handkerchief between fingers and thumb. As a preventive, bromide of potassium, in doses from 2 to 5 grains, with 5 drops spirits of ether or tincture of valerian is useful. Examine the teeth and watch the bowels, so that any cause of irritation may be removed.

St. Vitus' Dance or Chorea is discussed on p. 125.

Water-in-the-Head is considered on pp. 101 and 102.

Paralysis as it sometimes attacks children is discussed on p. 122.

Fevers and other Infectious Diseases.

These have already been discussed elsewhere.

Scarlet Fever, - - -	Refer to p.	399
Measles and German Measles,	,,	400
Typhus Fever, - - -	,,	410
Typhoid Fever, - - -	,,	411
Small-pox, - - - -	,,	402
Chicken-pox, - - - -	,,	410
Whooping-Cough, - - -	,,	416
Diphtheria and Croup, - -	,,	417
Mumps, - - - - -	,,	153

Scrofula and Consumption.

Refer to pages 431 and 282.

Mothers who are concerned about the delicacy of some child should take special pains in guarding and rearing it, after the manner suggested on pages 282 and 431.

Skin Diseases.

Skin diseases have been sufficiently discussed in Section XI., page 311 and following pages. In general they are to be treated by dieting, attention to the bowels, and frequent use of the bath and carbolic-acid or tar soap.

Nettle-rash.—See p. 314.

Red-gum Rash.—See Lichen, p. 319.

Tooth-rash is similar to the above, and to be treated in the same way.

Scalled-head. See Eczema, p. 318.—It may, however, be noted here regarding this skin affection that it is attended by the formation of "watery heads," which leak, are very itchy,

and give rise to yellowish-green scabs. It occurs often on the head, ears, nose, &c. The scabs should be got rid of by warm poultices of soft mashed turnips. Bathing with warm water to which a pinch of soda has been added will relieve the itching. When the scabs have been *completely* removed, the ointment mentioned on p. 319 should be used; or better still a new ointment called chrisma sulphur. The child's system should be strengthened by cod-liver oil, chemical food, &c.

Running Ears should be treated by gently syringing the ears twice or thrice daily with lukewarm water (see p. 382).

Rickets.

Refer to p. 30.

Bow-legs are to be prevented by treatment similar to that for rickets.

Accidents.

Scalds and Burns.—Remove the clothing as carefully as possible. Put the child in bed and see that it is warm. Arrange a box, wire-guard, or other similar contrivance over the burned part to keep off contact with bed-clothes. Under such an arrangement the injured part is to be kept free from cloths, cotton or other material, while at the same time kept warm. Paint the part, by means of a feather, with a mixture of equal parts of raw linseed-oil and lime-water. This is very cool and soothing if freely and frequently applied. In every house a bottle of this mixture should be kept, and quickly painted on the slightest burn or scald. Should a child's clothing take fire, throw over it a shawl, blanket, or other woollen article, and so smother out the fire. If the mouth or throat have been severely scalded, let ice be sucked till medical aid is obtained.

Wounds and Bruises.—If the wound is clean cut, bathe with cold water. This, with gentle but firm pressure, will stop bleeding. Remove any dirt or other foreign matter; bring the edges together accurately and keep them there with plaster and a bandage. To bruises apply cold-water cloths *if it is attended to at once.* This prevents swelling of the part. Any swelling, blueness, &c., which may result can afterwards be got rid of by aid of warm-water cloths. For wounds and bruises a recent remedy is very valuable, the extract of witch-hazel. It is sold in America as Pond's Extract. The writer has found it of great value for *external* application.

Sprains.—Rest is the main treatment. If the sprain receives immediate attention, surround the parts with cloths wrung out of iced water. This keeps down the swelling and relieves pain. Later, or if the cold applications are disliked, apply warm cloths. When all pain and inflammation have quite passed away, *but not till then,* rubbing with or without liniment will help to restore the use of the part.

Falls on the Head should receive careful attention. The child should be put to bed and keep quiet for the day. He should also receive a large dose of purgative medicine, castor-oil or syrup of senna. Cold cloths should be kept to the head and only milk diet allowed. If the child is cold warm bottles should be applied to the lower limbs, and the body gently rubbed, *but no stimulants of any kind should be given.*

Bleeding from the Nose may be controlled by the application, over the bridge of the nose, of sponges soaked in cold water. If it occurs frequently without known cause, let the child's health be inquired into. If it is a stout, evidently full-blooded child, keep the bowels free, and let the diet be very simple. If, on the other hand, the child is delicate, it should have an iron tonic, like chemical food, and cod-liver oil, and plenty of nourishing food.

Foreign bodies in the Nose and Ears, &c.—(1) If the body is in the nose, the child should be made to take a deep breath, then the free nostril closed, and a strong effort to blow through the blocked nose will often succeed in dislodging the substance. (2) If the body is in the ear, syringing may be used if *the body is not a pea or a substance that can suck up the water and swell.* Pins, bodkins, &c., should be used with the utmost care, especially in the ear, where a slight thing will injure the delicate drum of the ear and destroy the power of hearing on that side. (3) If a child has swallowed a pin, a coin, or other foreign body, purgative medicines should not be given, nor much fluid food, but plenty of soft food, like porridge, rice, corn-flour, saps, &c., which may surround the body and prevent it injuring the stomach or bowels.

Choking.—If a piece of food has stuck in the throat, support the child's head by the left arm, open the mouth with the handle of a spoon or a piece of wood, pass in the forefinger well to one side of the mouth against the cheek and push it right back into the throat. By sweeping the finger round, the mass may be hooked out.

SECTION XVI.—RATE OF GROWTH OF CHILDREN.

Period and Rate of Growth in Children:
The Value of Periodical Measurements.
Standards of Growth:
Tables showing Height, Weight, &c., at different Ages—
(1) in boys and men of the artisan class,
(2) in girls,
(3) in boys and men of the most favoured classes.
Comparison between Growth of Boys and Girls, and between Growth of Boys of different Classes.
The Relation of Height to Weight—Tables showing Increase in Weight corresponding to a certain Increase in Height.

Period and Rate of Growth in Children.

In the last section the management of children from birth up to a few years of age has been entered into in some detail. It is not necessary to follow up that section with one considering the management of children from the earlier years to the age of manhood or womanhood. The lines on which such management should proceed are practically similar in both instances. For details regarding food, clothing, exercise, &c., reference can be made to the part of the work devoted to Hygiene, from which full information can be gleaned. Investigations undertaken in recent years, however, have shown that parents and guardians of children have always at hand a simple and reliable means of informing themselves of the general state of physical health and growth of the children under their care, a means of assuring themselves that their method of watching over the bodily well-being of the children is attaining its purpose. This means consists in observing accurately, from time to time, the growth of the children in height and weight.

A large number of statistics shows that up to the age of about 22 years in boys and 18 in girls an uninterrupted increase in height occurs in a state of health, accompanied by a regular increase in weight. The rate of increase varies with the year of life, and, indeed, also with the season of the year. Moreover, a multitude of observations has shown that for each year of life there are a certain height and weight and a certain rate of increase which can be set down as the standard for that year. Diseased conditions, whether apparent or not, seriously affect this normal increase. Any wide departure from the general rule, if not actually in every case indicative of disturbance, becomes at least a signal of possible danger and a warning of the need of careful inquiry into the state of health. Here, then, is a valuable means, ready to the hands of parents and all who are in charge of children, of assuring themselves from time to time of the general health of their children and of the results of their management of them.

For the proper carrying out of the method a register requires to be kept. The name of the child is entered, and opposite each observation the date should be written. At regular periods, say at intervals of one month, the height and weight should be measured and duly noted. The height is measured from the sole of the foot to the crown of the head; shoes are, therefore, removed. The weight ought not to include clothes; and as the amount of clothing varies at different times, it is well to take the weight with clothes and shoes, and then weigh these separately, deducting their amount from the total. Besides the height and weight the measurement round the chest is valuable. It should be taken next the skin—without clothing, that is to say. The measuring tape is placed quite horizontally round the chest. The lower edge in front touches the upper part of the nipple and includes the lower part of the shoulder-blades behind. To ensure that the chest is always expanded with air to the same extent the person is made to count from one to ten, when the measurement is taken. The arms should, at the time, hang loosely by the sides.

The Value of such Periodical Measurements is shown by a variety of circumstances. Dr. Percy Boulton gives one instance that occurred at the Boys' Home, Regent's Park: "In 1875 it was found at that institution that the boys had not increased on an average 2 inches a year, so, in January, 1876, a revised dietary was used, and it was found after one year that, by this simple change, the average increase amongst the boys had been over 2 inches in stature and 6¼ pounds in weight." In prisons and lunatic asylums the inmates are weighed once a month, and the information given by the scales is taken as an indication of the sufficiency of the diet in quantity and quality. But the

information is of further value. If the weight is not satisfactory, and no error in diet accounts for this state of affairs, an examination of the person is made. As a result maladies are discovered in an early stage, before other signs had made themselves manifest; and thus disease is detected at an early stage, when it may be more easily and successfully treated. It has been shown that loss of weight is one of the earliest occurrences in consumption, and may be detected before cough has begun.

Everyone knows that young people who are growing rapidly are, as a rule, more easily fatigued and can stand less bodily and mental strain than others. If regular measurements were taken and showed that a rapid increase in height was taking place, unaccompanied by a corresponding increase in weight, it would be a sufficient warning of the necessity of care and avoidance of undue exertion both bodily and mental. A boy or girl who exhibits rapid bodily growth, cannot be expected to exhibit the same mental activity as one whose energies are not so much diverted in one direction. Allowance ought, therefore, to be made in the former case for less progress in education and less inclination for school work. In such a case parents and guardians ought to refrain from endeavouring unduly to push school work, and ought rather to encourage open-air amusements and exercise. The reverse condition of unusual cleverness and devotion to books and school work, accompanied by diminished growth in height and weight, would be equally taken note of as undesirable, and instead of the mental application being applauded and encouraged it would be restrained until the verdict of the measuring rod and the scales was more favourable.

It has been very strongly urged by those who have devoted special attention to the functions of the brain and nervous diseases that such methods of regular measurement ought to be systematically employed by schoolmasters and all who have to do with the regulation of the education of children, and that physical growth rather than age ought to be the indication of the stage of progress in education. Such observations would show that mental dulness was often healthy, and would aid in distinguishing between pupils who were backward because of bodily conditions and those who were backward because of idleness and carelessness. They would also show that brilliance at school was often unhealthy and undesirable, and in need of careful restraint rather than encouragement.

Standards of Growth.

In order to obtain any benefit from the weighing and measuring of children, one must know what ought to be the height and weight of the child at particular ages, so that the ascertained height and weight may be compared with that which is taken as the standard in health. This standard has within recent years been supplied by very numerous observations made upon children and grown-up persons at various ages. Tables constructed on the basis of these observations will be given. The tables given are derived from Dr. Roberts' *Manual of Anthropometry.* At the top of each column of the table is noted the year of life, and below are given the mean height, the mean growth occurring from one year to the next, the mean weight and its mean growth from year to year. It is necessary to explain that mean height, mean weight, &c., imply the height, weight, &c., which were found to be the most common among the multitudes examined.

TABLE I.

Showing the Mean Height, Mean Weight, their Annual Rate of Growth, and the Mean Chest-girth, with its Annual Increase, of 13,931 Boys and Men between the ages of 4 and 22 Years, of the Population in Large English Towns—Artisan Class.

Age last Birthday.	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21 to 22
Mean Height (in inches), ..	38·5	41·0	43·0	45·0	47·0	49·0	50·5	51·5	53·0	**55·5**	**58·0**	**60·5**	**63·0**	64·5	65·5	66·0	66·25	66·5
Mean Increase in Height, ..	—	2·0	2·5	2·0	2·0	2·0	1·5	1·0	1·5	**2·5**	**2·5**	**2·5**	**2·5**	1·5	1·0	0·5	0·25	0·25
Mean Weight (in pounds), ..	44·0	50·0	54·0	57·0	59·0	62·0	66·0	70·0	74·0	**78·0**	**84·0**	**94·0**	**106·0**	116·0	122·0	128·0	132·0	136·0
Mean Increase in Weight, ..	—	6·0	4·0	3·0	2·0	3·0	4·0	4·0	4·0	**4·0**	**6·0**	**10·0**	**12·0**	10·0	6·0	6·0	4·0	4·0
Mean Chest-girth (in inches), ..	—	21·0	21·5	22·0	22·5	23·0	23·5	24·0	24·5	25·0	26·0	27·0	28·5	29·5	30·0	30·5	31·0	31·5
Mean Increase in Chest-girth, ..	—	—	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	1·0	1·0	1·5	1·0	0·5	0·5	0·5	0·5

Note.—The height is taken without shoes, but the weight included clothes (which are taken to equal 7 to 10 lbs.).

TABLE II.

Showing the Mean Height, Mean Weight, and their Annual Rate of Growth of 10,904 Girls, between the Ages of 5 and 18 Years, attending the Public Schools of Boston, U.S.A. (Bowditch).

Age last Birthday.	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Mean Height (in inches), ...	41·0	43·5	45·5	47·5	49·5	51·5	**53·5**	**56·0**	**58·0**	**60·0**	61·0	61·5	62·20	62·0
Mean Increase in Height, ...	—	2·5	2·0	2·0	2·0	2·0	**2·0**	**2·5**	**2·0**	**2·0**	1·0	0·5	0·5	—
Mean Weight (in pounds) including clothes, ...	40·0	44·0	48·0	52·0	56·0	60·0	**66·0**	**76·0**	**88·0**	**96·0**	104·0	110·0	112·0	114·0
Mean Increase in Weight, ...	—	4·0	4·0	4·0	4·0	4·0	**6·0**	**10·0**	**12·0**	**8·0**	8·0	6·0	2·0	2·0

Table II. is derived from Dr. H. P. Bowditch, and the girls were partly of American, Irish, and mixed English, Irish, and American parentage.

It is necessary to notice the difference between the physical conditions of the boys and men of Table I. and the girls of Table II., else erroneous conclusions would be drawn. The boys of Table I. belong to the artisan class, living in large English towns. They are, therefore, not in circumstances best fitted for natural and unimpeded growth. They are statistics of boys subject to the more or less constant influence of at least not quite healthy surroundings, bad air, not too abundant nourishment, and labour begun in early youth, just at the period when growth ought to be most rapid. The girls of Table II., on the other hand, belong to a more favoured class, at least including many of the more favoured classes, likely, therefore, to show statistics of better stature and weight.

In order to show the differences in growth due to more favourable physical conditions of life, Table III. is given, dealing with boys and men of the most favoured classes, as found in English public schools, in the army, navy, universities, and medical schools. Thus Tables I. and III. will afford standards for boys and men, whether belonging to the artisan or more favoured classes, and Table II. will afford a standard for girls. Tables II. and III. will also permit a more reliable comparison to be drawn between the growth of girls and that of boys.

TABLE III.

Showing Mean Height, Mean Weight, Mean Chest-girth, and Mean Annual Growth of 7709 Boys and Men, between the ages of 10 and 23 Years, belonging to the most Favoured Classes of the English Population (Roberts).

Age last Birthday.	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Mean Height (in inches),	53·0	54·5	56·5	58·5	**61·0**	**63·5**	**66·5**	**68·0**	68·5	68·75	69·0	69·0	69·0	69·0
Mean Increase in Height,	—	1·5	2·0	2·0	**2·5**	**2·5**	**3·0**	**1·5**	0·5	0·25	0·25	—	—	—
Mean Weight (in pounds) including clothes=9 pounds,	67·0	73·0	80·0	88·0	**98·0**	**110·0**	**126·0**	**140·0**	146·0	148·0	150·0	152·0	—	—
Mean Increase in Weight, ...	—	6·0	7·0	8·0	**10·0**	**12·0**	**16·0**	**14·0**	6·0	2·0	2·0	2·0	—	—
Mean Chest-girth (in inches), ...	—	—	27·5	28·5	29·5	31·0	33·0	34·0	34·5	34·75	35·0	35·25	35·5	35·75
Mean Increase in Chest-girth, ...	—	—	—	1·0	1·0	1·5	2·0	1·0	0·5	0·25	0·25	0·25	0·25	0·25

Comparison between Growth of Boys and Girls, and between Growth of Boys of Different Classes. Comparing first of all Table I. with Table III., it is evident that the boys and men represented in the latter are in a better physical condition than those of the artisan class. At the age of 21 the most favoured class has a mean height of $2\frac{1}{2}$ inches greater than

the artisan class. The tables afford no means of comparison below the age of 10 years, but at that age the most favoured class has still the advantage of $2\frac{1}{2}$ inches. At the age of 16 the difference in height between the two classes is as much as $3\frac{1}{2}$ inches, due to the very rapid rate of growth about that age among the favoured classes, among whom it is greatly reduced in the 18th year, while in the artisan class the greater rapidity of growth does not begin so soon, does not go on so quickly, but lasts a year longer, so that the great difference in height at the age of 18 becomes reduced during the succeeding year. These differences are undoubtedly due to the less fortunate circumstances of the artisan class, which not only diminish the rate of growth but actually lessen its total amount. Similar differences are exhibited in respect of weight and chest-girth. At 21 years of age the artisan is a mean of 16 pounds lighter than his more favoured neighbour. At 10 years of age the difference is only 1 pound, but it is gradually and steadily increased, and the most favoured class have a permanent advantage of some 14 pounds in weight. In chest-girth at 21 the artisan is nearly 4 inches less than the youth of the non-labouring class.

A perfectly accurate comparison between the growth of girls and boys is not obtainable from the tables, for the girls belonging to Table II. were not drawn exclusively from one class. But the table shows that girls attain their full height earlier than boys by between two and three years, namely at 17 years, and that their mean height is from 4 to 7 inches less than men. Even at birth there is a difference in height and weight between male and female children to the advantage of the former. The difference in weight between the two sexes and in chest-girth is also marked. What is specially worthy of note, however, is that it is between the 11th and 13th years that growth is most rapid in girls both in height and weight. After 14 growth, which began to lessen the year before, rapidly diminishes, and is reduced to very little after 16. This rapid falling off in growth is coincident with other changes of great importance discussed at length in Sect. XVII.

In the tables the figures between the years when growth becomes most rapid and then falls off are given in black type for the sake of emphasis.

The Relation of Height to Weight. It is of importance to notice that increase in weight should occur in a regular way with increase in height. The following table is given by Dr. Percy Boulton in the *Lancet* of Oct. 16, 1880, as a reliable working standard. It is deduced from the results of observations of the same children who were examined at least once annually. The children were selected as average children of healthy well-to-do parents, brought up with suitable food and surroundings, giants and dwarfs being excluded.

TABLE IV.

Showing the Relation between Height and Weight (Boulton).

A child of	3 ft.	0 in.	should weigh	2	stones	8 lbs.
,,	3 ,,	1 ,,	,,	2	,,	10 ,,
,,	3 ,,	2 ,,	,,	2	,,	12 ,,
,,	3 ,,	3 ,,	,,	3	,,	0 ,,
,,	3 ,,	4 ,,	,,	3	,,	2 ,,
,,	3 ,,	5 ,,	,,	3	,,	4 ,,
,,	3 ,,	6 ,,	,,	3	,,	6 ,,
,,	3 ,,	7 ,,	,,	3	,,	8 ,,
,,	3 ,,	8 ,,	,,	3	,,	10 ,,
,,	3 ,,	9 ,,	,,	3	,,	12 ,,
,,	3 ,,	10 ,,	,,	4	,,	0 ,,
,,	3 ,,	11 ,,	,,	4	,,	2 ,,
,,	4 ,,	0 ,,	,,	4	,,	4 ,,
,,	4 ,,	1 ,,	,,	4	,,	$6\frac{1}{2}$,,
,,	4 ,,	2 ,,	,,	4	,,	9 ,,
,,	4 ,,	3 ,,	,,	4	,,	$11\frac{1}{2}$,,
,,	4 ,,	4 ,,	,,	5	,,	0 ,,
,,	4 ,,	5 ,,	,,	5	,,	$2\frac{1}{2}$,,
,,	4 ,,	6 ,,	,,	5	,,	5 ,,
,,	4 ,,	7 ,,	,,	5	,,	$7\frac{1}{2}$,,
,,	4 ,,	8 ,,	,,	5	,,	10 ,,
,,	4 ,,	9 ,,	,,	5	,,	$12\frac{1}{2}$,,
,,	4 ,,	10 ,,	,,	6	,,	1 ,,
,,	4 ,,	11 ,,	,,	6	,,	$3\frac{1}{2}$,,
,,	5 ,,	0 ,,	,,	6	,,	6 ,,

The general conclusions will best be given in Dr. Boulton's own words. "I find," he says, "that average English children, brought up under favourable circumstances, grow from 2 to 3 inches a year. *A growth of less than* 2 *inches or over* 3 *should excite apprehension.* The former would indicate arrested development, and the latter a rate of growth beyond the powers of average children. Rate of growth should be regular, and, being so, prognosticates future stature, because the healthy child that grows 2 inches a year passes 5 feet at about 15, which indicates a short stature (*i.e.* if a male about 5 feet 6 inches, female about 5 feet 1 inch). The healthy child growing $2\frac{1}{2}$ inches a year is 3 feet 2 inches at 3 years, and passes 5 feet at 13 to 14 years. Such child will be a medium-sized adult (*i.e.* if a male about 5 feet 8 inches, female about 5 feet 3 inches). The quick-growing healthy

child that accomplishes 3 inches a year passes 5 feet at 10 or 11, and eventually makes a tall adult (*i.e.* if a male about 5 feet 10 inches, female about 5 feet 5 inches). . . . Of course one meets with many variations, but these variations are, I believe, always abnormal. Some children seem to do their growing by fits and starts, the common diseases of children arresting, for the time, their progress, which is made up for afterwards by a supreme effort. Such growth is unnatural and often very detrimental. I believe, then, that every healthy child has its own regular rate of growth of 2, 2½, or 3 inches a year, from which it has no right to vary more than ¼ inch a year."

"Next as to weight for height, whether a child grows 2, 2½, or 3 inches a year, weight for height should be, in each case, identically the same; and all children should grow broad in proportion to their height. *Between* 3 *and* 4 *feet the increase in weight should, I find, be* 2 *pounds per inch, and between* 4 *and* 5 *feet* 2½ *pounds per inch.*" . . .

"Some children exceed these weights (those given in Table IV.) that are by no means giants, and really healthy, well-nourished children of healthy parents and favourable surroundings generally attain these averages. But what of children that fall below the standard? I find that there is a 7-pound margin of safety, and that children falling more than 7 pounds below this standard are devoid of reserve capital on which to draw, and, consequently, they succumb quickly to many constitutional diseases. This, therefore, may be called the preventive-medicine margin, beyond which lies the dangerous land of cachexia" (a depraved condition of body).

"Arrest of growth or loss of weight precedes so many diseases that it may be looked upon as a danger signal; and, if the caution is noticed before the disease point is reached, catastrophe may frequently be prevented."

These tables are given as standards for reference, and brief suggestions will be given in closing this section as to their method of use.

Each child should be weighed and its height taken once a month, or at least once a quarter. Reference should then be made to Table I. or III. in the case of boys, according to the class to which the child belongs, the labouring or more favoured class, or to Table II. in the case of girls. It will thus be seen whether the child reaches the standard for its age. The column of the table is taken headed with the age of the child at its last birthday; and in that column will be found the height, weight, and chest-girth to which it should reach. The results of each weighing and measuring should be noted in a book kept for the purpose, the date being accurately entered. The increase that has taken place since the last trial should be noted and compared with the standard in the tables. Lastly, the height of the child should be referred to Table IV., and it should be noticed whether the weight reaches to that mentioned in the table as proper to the particular height.

Of course there will be variations. Any considerable variation, however, and specially any sudden variation, should lead to careful consideration of all the child's circumstances, its food, the fresh air and exercise obtainable by it, the amount of school and other work, &c. Some change in these may at once be suggested. If no such circumstance seems to account for the departure from the rule, medical advice should be sought.

Especially between the ages of 11 and 17 should the results of the weighing-chair and measuring-rod be carefully watched. They will throw light on the question of over-pressure at school, and, if their warning is accepted, will do much to prevent it. Every school ought to have a room set apart and equipped for the weighing and measuring of the pupils. The standards of weight and height should be painted on the walls, and each pupil's height, weight, and chest-girth should be registered at regular periods. Education would then have a better chance of being conducted on physiological principles, and with some regard to the physical development of the pupils.

SECTION XVII.—HEALTHY WOMANHOOD AND THE DISEASES OF WOMEN.

Healthy Womanhood.

The Diseases of Women.

HEALTHY WOMANHOOD.

In the preceding section statistics have been given showing the rate of bodily growth in weight and height of both sexes. From these tables also it will be observed that in girls, between the ages of eleven and thirteen, increase in height and weight becomes more rapid than at any other period of life, while growth begins to diminish at thirteen years of age, and at the age of sixteen it begins to cease. A similar occurrence is evident in the case of boys, but several years later. This comparatively sudden falling off in physical growth is coincident with the attainment of the period of puberty. Puberty is derived from a Latin word, *puber*, signifying of ripe age, or adult. The age of puberty is the period when the development of certain organs, devoted to the function of reproduction, so advances that the person becomes capable of discharging that function. As this period arrives the energies, formerly devoted mainly to the building up of the general bodily structure, become largely diverted, and the increase in height and weight is thus rapidly diminished. It is just previous to the arrival of this period that the marked increase in stature and weight occurs. Both these occurrences are indications of critical stages in the life history of the individual. The period before puberty, the *prepuberic period*, as it is called, is a time when the nutritive processes of the body are in a condition of high activity, as is sufficiently indicated by rapid growth, and the equally rapid falling off in growth is also indicative of profound constitutional changes. Both are periods which make exceptional demands on the bodily powers, and which are, therefore, attended by risks of their own, specially so in girls in whom the changes connected with this stage of life are more rapid than in boys. It is a time of instability, a time when all the powers of body and of mind are sensitive to slight influences and easily overbalanced. It will be well, therefore, to indicate briefly what suggestions physiology has to make to parents and guardians to aid them in their appropriate guidance of girls under their charge. First of all, and in general, reference may be made to the last section where the advisability is urged of observing, at periodical times, the rate of growth in height, and the relation of height to weight, as indicative of the condition of bodily health and vigour. Any marked variation from the standard there given should lead to more detailed examination of the state of health, and if need seem, to an examination by the family physician to ensure that nothing is wrong. In this respect girls and boys are to be treated in the same way. Some special remarks are called for, however, in regard to the dress and education of girls.

THE DRESS OF GIRLS.

Conditions of Healthy Dress.—Strictly speaking there is only one purpose of dress, and that is to maintain the whole body at an appropriate and equal degree of heat. That main purpose being fulfilled, there are various secondary conditions to be kept in view. The dress ought to be light so that the bodily energy is not taxed to carry about an unnecessary weight, and it ought to be so adapted to the body as to leave unhampered all the natural movements of the body. This second condition implies not only that the movements of the limbs shall not be restrained, but also that such movements as those of breathing shall in no way be impeded, and that, as another example, no part of the clothing shall so constrict a part as to interfere with the natural flow of blood in it. The main purpose of clothing being fulfilled in accordance with these conditions, it is time enough to consider how the dress can be made graceful or becoming.

Common Errors in Girls' Dress.—It is easy to point out how the ordinary dress of women and girls breaks the above rules. It is not arranged so as to keep the whole body equally warm. There is more clothing over the hips than on any other part of the body. All the underclothing leaves the neck and shoulders practically bare, and when they are covered it is only by the bodice of the dress. Unless the sleeves are tight-fitting the arm is really exposed up to the elbows, while, owing to the looseness of the skirts, the legs from the knee downwards are insufficiently protected. If the clothing is improperly distributed as regards warmth, it is as apparently improperly distributed for purposes of easy carriage. The heaviest portion of it hangs from the waist, and the weight itself necessitates the drawing of the garments tight that they may be properly supported, so that the one evil leads to another. On the other hand, garments dependent from the shoulders are easily borne, and entail no undesirable constriction round the waist. A third point in which female dress is strikingly at variance with the conditions of healthy dress is in its undue weight. It will be admitted that the total

weight of the clothing is out of all proportion to the degree of warmth that it is required to maintain, and that if only warmth and protection are to be taken into account, much of it is superfluous. Thus the weight is not only badly arranged for easy carriage, but it is excessive in amount. This becomes a very important question in relation to exercise. The addition of one or two pounds weight needless clothing may seem a trifling affair, but when one considers the bodily energy expended in carrying these few pounds a distance of a few miles, it is easily seen that that slight extra weight may be indeed a serious burden, even in the ordinary movements of locomotion, and becomes an unconscious hindrance to free and vigorous exercise. Custom prevents this being fully appreciated, but women themselves know well how weighed down they feel when walking with clothing wet with rain. The increase in weight is not much, but it is felt as a load, just because it is more than they are accustomed to. Perhaps female dress does not err, from a healthy standard, more grievously than by the undue restriction of movement which it enforces. It is needless to say that the movements of the legs are very limited, and that running or jumping would be accomplished with difficulty. Tight sleeves seriously press on parts, especially at the armpits, and impede the circulation in the arm; garters, by their pressure below the knee, offer a very considerable obstacle to the return of blood in the veins from the parts below, and directly encourage the production of dilated veins with all their attendant evils.

The Evils of Stays, and the Deformities they produce.—These mistakes are as nothing to that of tight-lacing, and the evils they produce are small in comparison with those that attend this larger and greatest of all evils of feminine dress. The real effects of tight-lacing ought to be thoroughly considered. First of all, it undoubtedly impedes the full expansion of the lungs. In the section on Respiration it is explained (p. 254) that the act of breathing consists of an expansion of the chest in every direction; the cavity of the chest enlarges and air rushes in to fill up the lungs, and so occupy the increased space: thereafter the chest returns to its usual size, and air is thus expelled to permit of a diminution in the expansion of the lungs to fit the diminished space. The chief way in which the chest cavity enlarges is by the descent of the diaphragm, which is at once the floor of that cavity and the roof of the cavity of the abdomen or belly. When the diaphragm descends it does so at the expense of the belly cavity, on whose space it encroaches, and to make additional room the front and side walls of the abdomen bulge outwards. Now if the waist and part of the chest are encircled by a tightly drawn and, by the agency of steel, practically unyielding structure like stays, this movement of the abdominal walls cannot be developed, the descent of the diaphragm is arrested, and expansion of the chest in this direction becomes difficult. To compensate for this, enlargement must take place by exaggerated raising and widening of the upper part of the chest through movements of the ribs. The lower part of the chest is restricted in movement, and in the upper part the movement is overdone. The lungs are thus insufficiently and improperly inflated, in their upper portions having to bear an unnecessary strain, and their lower portions being seldom properly distended at all. Moreover, the constant pressure exerted by the stays forces inwards the lower ribs and specially the last two on each side, the floating ribs, which have no attachment in front, and forces in to some extent also the lower ribs next to them, so that the shape of the chest becomes actually altered, and instead of being broad and expanded low down, it is narrowed and drawn in. All this means diminished breathing space, enfeebled breathing power, and its indirect consequences it is difficult to estimate. But more than this. The pressure exerted by tight stays seriously alters the proper positions of the various organs in the abdomen. It is difficult to state with any accuracy how many different kinds of disturbance of a good state of health may arise in this way. The normal circumference of the waist ought to be from 25 to 27 inches. Under the influence of lacing this may be reduced to 20 or 22 inches, and even less, 16 inches being considered by some fashionable dressmakers the goal to be reached. Now all this constriction takes place at the expense of the space within the abdomen, and partly within the chest; for, as has been stated, the lower ribs are easily compressed from the slight nature of their attachments in front. Now in the ordinary condition every inch of space is occupied by the various organs, and the compression can only be exercised at their expense. The stomach, bowels, and liver will be directly affected, pressed together to some extent, and also to some degree forced upwards or downwards. This undue pressure tends to prevent full growth of the parts, and even if they have previously been fully developed, some degree of wasting

(atrophy) or shrinking. After death the liver on examination has been seen to bear permanent marks of the ribs pressed on it by tight-lacing. For even though the pressure is relaxed every time the corsets are removed, the continuous daily recurrence of the compression gradually establishes a permanent state of constriction, so that the parts do not return to their normal size on removal of the pressing force. It is undoubted that indigestion, disturbances of the liver and bowels—even ulceration of the stomach—have been the results of the persistent practice of wearing tight stays. Besides being themselves directly affected in this way, these organs, according to the amount of displacement they are bound to experience, alter the relations of others. Pressed upwards they encroach on the space that ought to belong to heart and lungs, breathing is disturbed, and the natural action of the heart interfered with. Palpitation, faintness, and many other heart symptoms may be the direct consequences. Then the pressure exerted downwards inconveniences the bladder, and is a very frequent cause of altered positions and disordered functions of the special female organs. Displacements of the womb, with all the manifold influences they may have on the monthly illness, are recognized as often produced by such a cause as this. While such evils as these result from the practice, what benefits, it may be asked, are supposed to be derived from it? It can hardly now be maintained that the "taper-waist" is desirable from its beauty. Any standard of beauty as regards human form is derived rather from that which appears to be most perfect in its development and most natural in its outlines. Greek statuary shows with perfect distinctness the views held by the ancients on the subject. The Venus of Melos shows the natural outline of the waist, and is a model of what its sculptor must have esteemed an ideal of beauty. The wood-cut in the text, taken from a photograph, while it sufficiently indicates the outline, cannot suggest the dignity and grace which the statue itself so wonderfully exhibits. Let anyone compare this outline with that given to the female form in any fashion-plate, and there ought not to be much difficulty in admitting that the "taper-waist" is, strictly speaking, a deformity artificially produced. It is urged, however, that stays are necessary to distribute the weight of the clothes and to give some support to the back. As to distributing the weight of the clothes, it has been already indicated that the suspension of so many clothes from the waist, which is supposed to necessitate the use of the corset, is itself a grave mistake, and there can be no doubt that the clothes can be so adjusted from the shoulders as to render any such artifice as stays unnecessary. As to the need of supporting the back, that is rather the effect than the cause of stays. For the fashion in which, even from infancy, children

Fig. 182.—The Venus of Melos, showing the natural female form.

are hedged in, from the hips to the arm-pits, by a more or less stiff wall, is undoubtedly productive of feeble development and deficient vigour of the great muscles which run right down the back on each side of the back-bone. It is one of the first laws of growth that moderate and regular exercise of a part of the body strengthens that part; in short, that its strength is in proportion to the use that is made of it, and that, on the other hand, disuse of a part inevitably

tends to weakness and wasting. Now the swathing to which infants and young children are subjected so restrains the activities of the muscles of the trunk that proper exercise of them is impossible, and the corsets of later years even more effectually impede their activities.

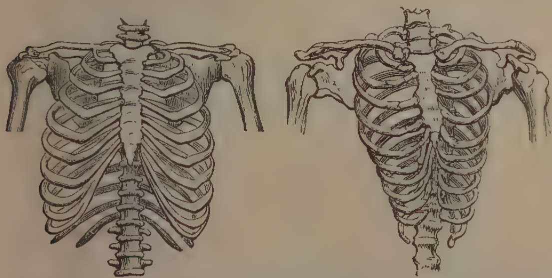


Fig. 183.—The Bony walls of the Chest.—That to the left shows the natural position, that to the right the deformed position due to tight lacing.

It is therefore the stays that render the back weak, not the weakness of the back that renders the stays necessary.

Suggestions as to Healthy Clothing.—These are some general criticisms meant to point out the errors, from a point of view of health, in the general character of woman's dress. It is only women themselves, however, who can successfully carry out any reform in this direction. Fashion is too imperious to bow to the authority even of health, and, probably, the necessary reforms will not all be carried out till the time arrives when health becomes fashionable. But even though the outward appearance of woman's clothing must be regulated, not by a question of comfort and physical well-being, but mainly by the whim and caprice of the rulers of fashion, every woman has it in her power, while submitting to the fashion-makers, to adapt her clothing in order that it may fulfil more thoroughly than it usually does its obvious purposes. That is to say, if a woman must conform to what other people wear in the matter of a cloak or a jacket, a bodice and skirt, and if she must cut her bodice in accordance with the mood of the times, and adorn her skirt with furbelows or frills as the newest style directs, she can at least exercise her own will as to the nature of that portion of her clothing which is not meant to be visible. Underclothing consistent with health is not a very elaborate affair. There ought to be a garment next the skin made of wool or flannel, shaped to fit easily. A knitted "suit" would probably be the most useful. It should reach up to the neck, fitting it as close as is comfortable, and ought to be provided with sleeves down past the elbow, also easy fitting. The lower part of this combination garment would extend below the knee. Over this linen garments might be put on according to the pleasure of the wearer, but they ought not to be made with that exuberance of material, both in length and breadth, which is customary, and which necessitates so many creases and folds and doublings. Thus a chemise might be made with some respect to the length and circumference of the body it was designed to clothe. Any petticoat ought not to be simply fastened round the waist, but ought to be suspended by something like braces from the shoulders, or by buttoning on to a light bodice. But if any additional *heavy* underclothing is required for more warmth it ought to approach as nearly as possible to a divided garment that will cover each leg separately. Such *light* petticoats as are worn for appearance need, of course, no such division. Now it cannot be said that underclothing of such description as this demands anything in the nature of stays, for there is no great weight in it, and what weight there is is borne from the shoulders. Stays, therefore, ought to be entirely discarded as an article of dress, of whatever description they may be, for children, girls, and young women. It may be admitted, however, that nursing mothers require more support to the breasts than ordinary clothing supplies, and that for them some form of corset is required. But this ought rather to be in the shape of a bodice made of stouter material than usual, and such a bodice could be readily made without the steel bands and other stiff structures of which ordinary corsets chiefly consist. Women who have naturally more largely developed breasts than usual could adopt such a form of support as would easily meet the requirements of comfort and appearance. This healthy form of underclothing that has been suggested, if it were adopted, need not interfere with the wearing of a dress and its bodice made according to the requirements of the times, and thus health and fashion would each have a due amount of regard paid to them.

As regards covering for the feet and legs, woollen stockings ought to be worn, but the usual method of securing them by garters round the knee is highly injurious. Any garter to be

sufficiently tight for this purpose must press on the veins of the surface, and thus impede the circulation in the skin. This obstacle to the free upward flow of blood from the foot and leg causes an accumulation of blood in the veins; the pressure of blood becomes so increased that the walls of the veins are apt to yield, especially in older persons, and varicose veins or a swollen and inflamed condition of the skin are in time the results. They often lead also to a feeling of weariness and pain, just owing to the interference with the circulation. The stockings ought, therefore, to be secured by suspenders connected with the shoulder brace or bodice. The form boots and shoes ought to take is considered under HYGIENE.

It cannot be too strongly impressed upon mothers and those who have the charge of girls that attention ought to be paid to the clothing of girls, to ensure that the purposes of clothing are carried out, and are not carried out in any way that is inconsistent with the highest degree of health and healthy growth. Many of the most serious evils of a woman's life, and an innumerable number of the minor ailments, that seem little in themselves but nevertheless among them make the difference between an active, bright, and energetic woman, and an ailing and feeble woman, are the result of mistaken notions in clothing of which the woman was the victim during the period of childhood and youth. Grown-up women may dress themselves as they please, and may violate the laws of health, if they choose to sacrifice themselves to foolish notions of what is desirable in female form, but they are not entitled to humour their fancies in the dress of their children, if the methods they adopt are likely to hinder the healthy growth of the children, or tend even indirectly to encourage feebleness.

THE EDUCATION OF GIRLS.

Higher and University Training.—It used to be a common subject of discussion whether women are intellectually inferior to men, and it was also commonly concluded that they are. Whether that be so or not, it is a fact that woman was for many centuries kept in subjection, and that indeed it was not till the advent of Christianity that woman was called to occupy her position as not the inferior but the complement of man. If there is any truth in heredity, this long-continued subjection must be taken into account, and the suggestion of the old question that girls should not receive so complete an education as boys, because they are unfit for it, must be set aside.

Without attempting a logical definition, we may say that education has as its objects the leading out or developing of all the powers of mind and body; and even if it were admitted that woman is mentally inferior to man, that is only an additional reason for more careful, and complete, and well-adapted training. Linked with man in life's work, and one with him in destiny, why should woman be less carefully prepared for the duties of life or less fitted for its issues? Accordingly, now as complete an education is being gradually extended to girls as is given to boys, and in America, where especially the education of girls has been pushed with much eagerness, a university education is not debarred to them.

Opinions of various Authorities in England, America, and France.—Although sufficient time has hardly elapsed since this movement began its full swing to enable one to estimate accurately its effects, nevertheless a very considerable body of testimony is put forward to show that girls are not only fitted intellectually for the highest developments of education, but are not necessarily injured physically. Thus Mrs. Henry Sidgwick, speaking of her experience at Newnham and Girton Colleges at Cambridge, says, "the experience of Girton and Newnham certainly shows that the danger need not be alarming. The actual number of women who even temporarily break down at Cambridge from the effects of work is exceedingly small in proportion to the whole; and as for the average health of the hard-working students it is little to say that it would compare very favourably with that of girls who are laboriously devoting themselves to the pursuit of amusement. I think it may be asserted that it would compare favourably with the average health of young women generally in the class from which our students are drawn. In fact, overwork is an evil to which attention ought to be continually given, not so much because the danger of it is great, as because it is to a large extent preventible. A delicate woman may go, and frequently has gone, through the course of training for an honour examination without any injury to her health, and even with positive gain to it, from steady and not excessive work, with power, to a great extent, to choose her own days and hours for it; but even a strong one is liable to make herself ill unless she will observe the ordinary common-sense rules of health as to sleep, food, exercise, recreation, and other things."

Miss Freeman, President of Wellesley College, Massachusetts, judging from the experience of three colleges for women in the Eastern States of America, the Vassar, Wellesley, and Smith Colleges, where in 1883 there were more than 1000 women students, says the results have been "so manifestly good that they would go on, greatly trusting that in educating women's heads they would not hurt their hearts or ruin their constitutions."

Mrs. Richards of Vassar College offers proof of the possibility of giving girls a complete university education free from danger to health, in the shape of statistics concerning a large number of women who had studied and graduated at first-class institutions, and who had passed out of them from five to fifteen years before the date of inquiry. As a result of the inquiry "physicians had acknowledged that they were surprised at the comparatively good health of the educated women of America as shown by these statistics." According to Mrs. Richards, "experience had shown that if a girl was well cared for from twelve to eighteen, then went to college from eighteen to twenty-two, during that period there would be no trouble whatever." She hoped that those who had the control of education in this country (England) would look closely into that matter. It was, of course, very difficult to keep acquainted with those who had left college, but if some kind of record could be kept of their subsequent health, that would be the best answer which could be given as to the danger of the physical effect of education upon girls.

In France there is a magnificent college at Sèvres for women, the École Normale Secondaire Supérieure, concerning which Professor Darmesteter says "the system for the higher education of women had already produced good results, and he trusted that it was opening up a new era in the education of women." Similar testimony comes from Germany.

There is, of course, another side to the question. The modern objections to an education for girls as complete as that for boys centre round the opinion that such education unfits girls, by the nervous strain to which they are subjected, for their duties in life as wives and mothers. There is evidence in support of that opinion. Professor Loomis, of Yale College, regarding the increasing physical deterioration of American girls, says "the cry to our older colleges and time-honoured universities is: Open your doors that the fairer part of creation may enter and join in the mental toil and tournament! God save our American people from such a misfortune!" This, however, it is right to say, was the opinion of Professor Loomis at a much earlier period than the testimony in favour of university education for girls already given. Dr. Withers Moore of Brighton gave his address as President of the British Medical Association in 1886, on the subject of the higher education of women. He asks, "Is it for the good of the human race, considered as progressive, that women should be trained and admitted to compete with men in the ways and walks of life, from which heretofore (as unsuited to their sex) they have been excluded by feeling and usage, and largely, indeed, by actual legislation?" He answers that "it is not for the good of the human race, considered as progressive, that women should be freed from the restraints which law and custom have imposed upon them, and should receive an education intended to prepare them for the exercise of brain power in competition with men. And I think thus," he continues, "because I am persuaded that neither the preliminary training for such competition work, nor the subsequent practice of it in the actual strife and struggle for existence, can fail to have upon women the effect of more or less (and rather more than less) indisposing them towards, and incapacitating them for, their own proper function—for performing the part, I mean—which (as the issue of the original differentiation of the sexes) Nature has assigned to them in the maintenance and progressive improvement of the species. . . . This 'higher education' will hinder those who would have been the best mothers from being mothers at all, or, if it does not hinder them, more or less it will spoil them." Dr. Moore cites in support of his opinion the views of Herbert Spencer, Dr. Matthew Duncan, Sir Benjamin Brodie, the late Dr. Edward H. Clarke (U.S.A.), Dr. Emmet of America, Mr. Lawson Tait of Birmingham, and others, mostly specialists in diseases of women.

The general strain of these opinions will be sufficiently indicated by the following from the late Dr. Thorburn, of Owens College, Manchester: "The struggle for existence on the part of single women, and the capacity of a few of their number to ignore, with safety, the physiological difficulties of the majority, are demanding opportunities for education, and its honourable as well as valuable distinctions, which cannot and ought not to be refused. Unfortunately, however, up to this time no means have been found which will reconcile this with the physiological necessity

for intermittent work by the one sex. It becomes, therefore, the duty of every honest physician to make no secret of the mischief which must inevitably accrue, not only to many of our young women, but to our whole population, if the distinction of sex be disregarded."

If, however, we carefully consider the burden of the objections raised to the full education of girls, and the recent developments of female education in England and America, some way out of the maze created by these differences of authority seems possible. We have to consider that many women find the necessity of earning their livelihood in occupations requiring careful education and a large amount of mental toil, and we find a large and daily increasing number of women who value the highest education, not for what it will bring, but for its own sake. The claims of neither of these can be disregarded. Up to the age of twelve years there is no reason why girls should not receive an education equal to, if not identical with, that given to boys. It is after that age that difficulties arise due to the special circumstances of sex. It is about that age that special developments take place in the training of boys dependent upon their intended course through life. If they mean to go in for commercial pursuits, the education is moulded in accordance with that intention, if for professional life, they go on to training preliminary to the universities. If they are boys who, by reason of their position, can afford to pursue an education whose immediate object is culture, and whose ulterior object may be determined at a much later period, according merely to fancy or inclination, the higher education of the secondary school and the university is proceeded with. This age is also the time when, in the case of girls, the special circumstances dependent on her sex require to be taken into consideration. The Americans seem to find that if, after that age, whatever may have been the system adopted before it, the education of girls is directed with special regard to her physiological necessities, that is with regard to the monthly changes which periodically occur, all danger may be averted. This almost implies that girls be taught, after that age, in secondary schools set apart for themselves, where they do not enter into competition with boys, and where, on that account, a periodical relaxation of studies may be permitted to occur without throwing one set of pupils out of line with another in rate of study. Still further to diminish all tendency to overstraining, the best American opinion seems to indicate the advisability of abolishing competitive work and examination among girls, and it is found that the love of work itself supplies sufficient stimulus to requisite exertion, that, even where competition is not engaged in, the eager desire for learning requires careful watching to hold it sufficiently in check. Similarly colleges for women only, where like care and supervision are exercised, seem preferable to mixed colleges where an unhealthy straining to excel is almost certain to exist. Such a regulation of study, in accordance with girls' physiological requirements, is only possible in an institution exclusively devoted to girls.

Overpressure in education has as pernicious an effect on boys as it has on girls. That evil is got rid of by proper regulation of study, and, along with care in diet, &c., by means of a due amount of exercise and recreation. This general rule is applicable to girls as well as to boys. The special objection in the case of girls is that the *continuous* mental application is not consistent with the special demands made upon a girl's energies at regularly returning periods connected with her peculiar functions. That objection, we believe, is met by such provisions as have been already indicated, which, however, as we have already said, can only be properly made in secondary schools and in colleges devoted exclusively to the female sex, and regulated with due regard to these functional peculiarities. In short, the objections that have been urged against the according of the highest education to girls do not strictly lie against the education itself, but against the system on which it has been conducted. The arguments are not logically against giving the same education to girls as to boys, but against giving that education *in the same way*. We believe the difference in the testimony that came from America at an early period in the movement for higher education, which was not in its favour, and the later testimony, when better methods had been devised, and which was in its favour, is simply due to that fact that the necessity for periodical relaxation had not been recognized at the early period, and was fully realized at the later. Thus one teacher in giving evidence before the State Board of Massachusetts, in 1874, said: "*At certain periods* I think that study with girls should wholly cease for some days. I refer to girls from twelve to twenty years of age. Anyone who has taught boys and girls—in separate schools, I mean—must have noticed the greater proportionate irregularity of attendance of the latter, and as a parent he would know the reason

and the necessity of cessation from work." Another says, "Could the custom of keeping girls between the ages of thirteen and nineteen out of school and at moderate rest *during certain periods* become established among us, a certain number might suffer restraint not absolutely demanded, but the general result would be an incalculable gain to the health, present and prospective, of the inhabitants of this commonwealth." Dr. da Costa, of New York, maintains that "common sense and the teachings of physiology point in the direction of lessening, as far as practicable, work *at a time when the whole system is depressed.*" Dr. Cohran of the New York State Normal School has been "compelled to the conclusion that the sexes cannot be educated *on the same system* with advantage, and that the physical disadvantages under which the female labours render it necessary that a system be devised so elastic, with so much optional work, that the female may rest, at least comparatively, *as the occasion requires.*" Those parts of the opinions have been printed in italics, which show clearly that the objections taken are not to the higher education in itself, but to the difficulty of reconciling it with the periodical change in women, and that difficulty later methods have to a large extent overcome.

The conclusion of the whole matter seems to be, let girls have the same education as boys and along with boys, if need be, up to the age of twelve years, overpressure being carefully avoided in the case of one as in the case of the other, a due amount of recreation and exercise being daily insisted on; after that age deny not to girls secondary and university education, but let it be conducted in institutions restricted to them, but as fully equipped and conducted by as able teachers and professors as similar institutions for boys, where, however, periodical variations in the amount and degree of mental effort can be arranged for in accordance with the periodical variations in the amount of energy that can be devoted to nervous activity, with proper regard to other requirements. By such means the world will be blessed with wise and cultured women, and will not be without vigorous wives and mothers, not less capable of the highest duties of womanhood, because to the sweet instincts of nature they add the rich treasures of a cultured mind.

THE FEMALE GENERATIVE ORGANS.

At the age of from thirteen to sixteen years, in temperate climates, changes occur in girls which indicate that a stage has been reached in the development of special organs, and that the girl has become capable of her peculiar functions. The main change is the occurrence of a discharge from the genital organs, which, because of its recurring at regular intervals of twenty-eight days or one lunar month, has been called the "monthly illness." Before considering what the discharge means, it will be necessary briefly to describe the organs concerned.

The female generative organs situated within the body are the womb or uterus and certain appendages, the ovaries, and tubes which lead

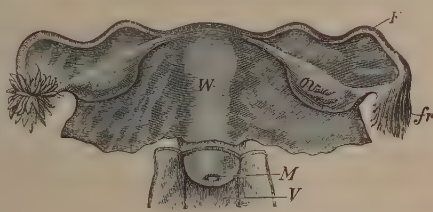


Fig. 184.—The Womb and its Appendages.

W, the womb. *ov*, the left ovary. *F*, the left fallopian tube, and *fr*, its extremity. *L*, the ligament of the womb. *M*, the mouth of the womb. *V*, the genital passage, opened up.

from them to the womb. The relation of these parts is shown in Fig. 184.

The womb or **uterus** is situated deep in the cavity of the pelvis (p. 22) between the bladder which lies in front of it, and the end of the large bowel which lies behind it. It is pear-shaped, and is on an average three inches long, two broad, and one thick. It is composed mainly of muscular fibre of the involuntary kind (p. 70). In its centre is a narrow cavity (the walls being very thick) running up towards the broad end of the pear-shaped organ, and opening at the narrow end at what is called the mouth of the womb. The inner surface next the cavity is lined with mucous membrane (p. 307), in which there are glands. The organ is richly supplied with blood-vessels and nerves. By means of a transverse slit, the lips of which are, however, in the virgin state closely applied to one another, the mouth opens into the passage of the vagina, which communicates with the outside, and is about 5 inches long. The womb is kept in position by ligamentous structures, which are lax enough to admit of a moderate degree of movement. Now the womb is flattened on its front and back walls, and if a pear be imagined as pressed somewhat flat in this direction it will be easily understood that the appearance of a corner at each side of the

broad end will be produced. The womb has such a corner at each side of its upper end, and from each of these corners a tube passes off, the **fallopian tubes.**

Fallopian Tubes. Each tube has the appearance of a thick cord, 3 or 4 inches long. It consists mainly of muscular tissue like that of the womb, and in the centre of its whole length runs a canal, the inner wall of the tube being lined by a membrane also like that of the womb, but having no glands imbedded in it. At the end next the womb the canal will admit only an ordinary bristle, but at its other end it is wider. The end distant from the womb opens into the cavity of the belly, is trumpet-shaped, and provided with fine finger-like projections or fringes. (See Fig. 184, *fr.*) The tube of each side is further connected with the womb by a broad band of tissue, a ligament. Connected with this ligament is the **ovary**, one on each side of the body.

The Ovaries are flattened oval bodies, each about $1\frac{1}{2}$ inch long, $\frac{3}{4}$ inch wide, and nearly $\frac{1}{2}$ inch thick. They are attached to the womb by means of the broad ligament referred to, and to one part of the ovary the fringe of the fallopian tube of its own side is connected. It is in the ovaries that the ova are produced,

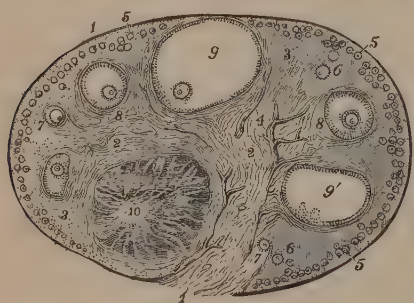


Fig. 185.—Section of Ovary magnified, showing ova in various stages of growth.

1, Capsule of ovary. 2, Fibrous substance of ovary. 4, Blood-vessels. 9′, Sac from which ovum has been removed. 10, Space from which ovum has been discharged filled up with blood-clot, &c. For meaning of other numbers, see text.

the female element in the production of new beings. The ovaries are supplied with many nerves and blood-vessels. Each ovary contains a multitude of ova or eggs in different stages of growth. In the ovaries of a female child at birth they are already visible, and it has been estimated that no less than 70,000 may be present in the two. Each ovum or egg is about the $\frac{1}{100}$th of an inch in size. Fig. 185 shows a section or slice of an ovary, the little round bodies being the ova, those near the surfaces (5) being undeveloped, those deeper (6, 7, &c.) being more mature. In process of growth the ova pass more deeply into the substance of the ovary. Instead of lying in groups, one becomes separated from others by growth of substance between them. As one becomes more mature it becomes surrounded by an envelope or capsule, which by and by forms a sort of bag round it. The ovum becomes attached to one part of the wall of the sac and fluid is produced separating the rest of the wall from it, and the fluid increases till the egg is, as it were, connected to the inner wall of a minute bladder. (See Fig. 185, 8 and 9.) As it grows, the sac with its ovum approaches near the surface of the ovary till it bulges from the surface. The continued increase of fluid finally causes the little bag to burst, and the ovum is discharged. The ovary at this time is very freely supplied with blood. The discharged ovum would readily drop into the cavity of the belly but for the fact that at this time the fringed end of the fallopian tube is applied to the ovary, and the ovum is received into the canal of the tube, and passes down the canal till it reaches the womb.

Thus during the early years of a girl's life the ovary is developing, and the ova it contains are maturing. It is not till the twelfth year or upwards that the first ovum becomes ripe and is discharged, and when that period is reached the girl has arrived at the age of puberty, that is, the age when she is capable of conceiving. At the time when an ovum is about to be discharged, changes take place in the womb; an extra supply of blood reaches it, and the changes occur which lead to the appearance of the discharge. From the time when the first ovum becomes mature and is discharged, as a general rule, one becomes ripe after another at intervals of twenty-eight days. Thus from thirteen years or so onwards regularly every month an ovum becomes mature and is discharged, and its period of ripening and discharge is attended by the changes in the womb alluded to, and so there is the periodical occurrence of the monthly illness. For a certain number of years—up to the age of forty-five or thereby—these changes regularly take place till the organs become exhausted, the period of the "change of life" arrives, these occurrences cease, and the capacity of conception has passed away.

MENSTRUATION.

Menstruation (*The Menses—Monthlies—The Periods—The Courses*) is the term applied to the process, whose external evidence is the discharge from the genital organs. The word is derived from the Latin *menstrualis*, meaning monthly, from *mensis*, a month.

Time of Appearance and Symptoms.—It is some time between the ages of twelve and sixteen years that the appearance of the monthly discharge indicates that the internal generative organs have arrived at some degree of maturity. Even before that occurrence various other signs indicate a change coming over the girl. An alteration takes place in the figure and gait owing to expansion of the hips and fuller and more rapid development of the breasts. The whole figure becomes more plump and rounded, and the girl less awkward and angular, and more graceful. Her manners also change. She becomes more sedate and less wayward, more timid and bashful, but also more gentle and loving. The actual period of the first illness varies with the climate and other circumstances. In Britain the age of sixteen is that at which it most commonly begins; in France it is earlier. The general rule is that it appears earlier in warm countries and later in cold countries, the mean being in a temperate climate. The date of appearance is also affected by the conditions of life. It is earlier among those who live in towns, and later among country girls. Luxurious habits of living, the use of warm stimulating foods, &c., hasten it; while among those whose lives are more simple and primitive, or who live among conditions of hardship, it is delayed. It is also influenced by the constitution, and its appearance may be long delayed in a delicate girl. There are also exceptional cases on record, cases where the illness has appeared remarkably early, or where it has not appeared for many years past the usual time. The first monthly illness is frequently accompanied or preceded by some degree of feverishness, pains in the back, a sense of fulness in the abdomen, and feelings of great weariness. It is also a time when a girl may manifest a variety of nervous symptoms, and may be liable to hysterical attacks. The first portion of the discharge is clear, later it is tinged with blood, and gradually it becomes almost pure blood, the blood then gradually diminishing till finally the discharge becomes free from blood and then ceases. The symptoms which preceded and accompanied the discharge pass off, and in a few days the girl is in perfect health.

The regular illness is not established all at once. The girl may suffer from some of the preliminary symptoms, which lead the mother to conclude her illness is going to begin, and after a few days they may pass off without any or but a very slight discharge appearing. And this may occur at one or two periods without any flow of blood. Or one illness may occur in the regular way, and one or two periods may then pass with only a threat of its occurrence. Parents must not be alarmed at such irregular occurrences. Nor are they to take, as is too often done, any steps to force the discharge, such as administering drastic purges and other kinds of medicine. The general health of the girl remaining good, no alarm need be entertained, and in any case no haphazard methods should be resorted to. (Refer to p. 483.) One thing it is desirable to notice here. The external passage (vagina) is almost closed in the virgin by a membrane called the **hymen**, which stretches across it near its entrance. Through a narrow opening in its centre, or through several smaller openings, the discharge from the womb escapes externally. In rare cases no opening exists, and the discharge does not escape but is pent up within. The girl may, at the usual time for the appearance of the discharge, have the symptoms that have been noted, but there is no flow; and thus one period after another may pass, the discharge accumulating behind the barrier. The accumulated discharge will in time form a swelling, even though it gives rise to no other symptoms, and there will be the appearance of a tumour in the abdomen enlarging with each returning period. This, taken with the absence of any discharge externally, has more than once given occasion for most unjust suspicion. In such a case as this the point to note is that on no occasion has the discharge ever appeared. If any discharge had at any period appeared, it would have proved that the way was open.

Once the discharge has been fully established it should return at the regular periods during the whole of the child-bearing epoch. It is, however, interrupted by pregnancy, and does not, as a general rule, occur during suckling. Its disappearance under any other circumstances is to be regarded as a disturbance of health, which will probably be attended by other symptoms also. The **duration of each illness** varies in different persons. According to one authority the most

common length of time is eight days, then three, and then four. The quantity of discharge during one period it is also impossible to state with definiteness. From 2 to 6 ounces may be stated as extremes which are within the limit of health. Any larger quantity should lead one to seek competent advice. While four weeks is the usual time that elapses from the beginning of one illness to the beginning of the next, there are variations quite consistent with health. One woman may "alter" every three weeks, and another only every six weeks. All departures from what is stated to be the general rule are to be judged by the custom of each person and by the condition of her general health.

The discharge comes mainly from the inner surface of the womb, and while it lasts the womb is in the condition of having a greatly increased blood supply, and of being in consequence fuller and heavier than during the interval between two periods. These changes in the womb, as already noted, are coincident with similar conditions in the ovary, attending the ripening and discharge of an ovum. In the virgin condition the ovum passing down the fallopian tube into the womb undergoes no change except that of breaking down and becoming dissolved.

The Change of Life.—At the age of forty-five or thereby, earlier or later in different individuals, the regular periodical illnesses begin to cease. They rarely cease at once, but become irregular. The "illness" returns at irregular intervals, and gradually the discharge diminishes in amount. It also greatly varies, being at one time scanty and at another very profuse, till it finally ceases. The womb at this time becomes smaller in size, and the ovaries shrivel rapidly. At this time the woman is in an unstable condition of health, and liable to many minor ailments, and also to some more serious. She is liable to headache, flushings of the face, and disturbances of the digestive and nervous systems. When this period is safely past, however, a time of good health may be looked forward to with some confidence.

Vicarious Menstruation.—This is the term which has been applied to a discharge of blood coming periodically from some part of the body other than the womb, and taking the place of that discharge, which is absent or very scanty. Instances of such menstruation are not very common. But there have been cases in which bleeding from the lungs, stomach, nose, &c., occurred at the usual period, and seemed to be the means of relieving the system when the ordinary discharge was wanting or scanty.

The Management of the Monthly Illness.—Details of the nature of the monthly illness have been given above, in so far as they seemed advisable for the purpose of communicating some intelligent appreciation of the character of occurrences of which every woman's body is the seat. It is but in accordance with reason and common-sense that a woman should have some degree of accurate knowledge of so important a function. Disturbances of this function are surprisingly common, are, indeed, apparently becoming more and more common, many of the conditions of modern life directly disposing to them. That they are the cause of much suffering, borne largely in silence, because of the natural modesty of women and dislike to seek advice on so delicate a subject, is known to every medical practitioner of even limited experience. Ignorance is undoubtedly mischievous, and a certain amount of knowledge on the part of every woman desirable. Nowadays the only question is how, when, and by whom ought the necessary information to be imparted to every girl. Every medical man recognizes that a little knowledge of the subject would enable women to avoid much of the misery and suffering they incur by their ignorance. For this purpose the above details have been given as plainly and simply as seemed to suit the circumstances of the case, and for the same purpose the following general directions as to the management of the "illness" are given.

It is because the occurrence of the monthly illness is natural and periodic that women, so familiar do they become with the process, pay little heed to its indications, and do not much take it into consideration in regulating their habits of life. In arranging for their work or their pleasure too little account is taken of it, though every woman knows pretty accurately the time of its return. Even when some disturbance arises connected with it, less attention is paid than would be to disorder of the same extent of any other function. All this is the very reverse of what ought to be. For, at the very outset, it must be remembered that at the period of the illness the whole system is in a highly-strung condition, extremely sensitive to every variety of influence; the nervous system, in particular, is peculiarly impressionable, and the person, therefore, more open than at any other time to disorder of various kinds. It would only, on this account, be in accordance with

reason and common-sense that special care should be taken while the illness lasts, and for a brief period both before it and after it, to maintain good bodily health, and to guard against everything likely to affect it. Thus common-sense would suggest that exposure to cold, to damp, to draughts, and such like should be avoided. Thus during the period mere jumping out of a warm bed and placing the bare feet on a cold floor or wax-cloth has often been the cause of serious illness. Wet clothing and wet feet are specially hurtful. If women would not permit the familiarity of the process to make them forgetful, it would not be necessary to insist on these obvious precautions. It requires very little thought, moreover, to make one perceive that, at a time when so much bodily energy is directed to one function, and when so great a drain on the system is present, less, considerably less, than the usual amount of exertion ought to be undertaken. Indeed, during the days that the illness lasts, much more rest than is customary ought to be indulged in, no work requiring any strain should be undertaken, fatigue should be carefully avoided, the ordinary duties should be lightened, and some rest and quiet taken during the day. This is not always possible; but every endeavour ought to be made, even when the usual day's duties must be performed, to make them as light as possible, and to undertake no exertion that can be avoided. If this is so with even necessary duties, it is excessive foolishness for a woman to expose herself to undue excitement during the period, specially the excitement of a round of pleasure or gaiety. Social gatherings, dances, games implying physical exertion, such as lawn-tennis, boating, riding or walking excursions—all these should be refrained from at such a time. Those who are in charge of houses ought not to leave the illness out of account in arranging their domestic concerns. The dreaded "spring cleaning" and the inevitable "washing day" ought to give way when necessary, and mistresses ought not to forget that some days of apparently slovenly and half-hearted work may have a reason other than than that of idleness or carelessness, and ought when needful to lighten the burden of work to their servants accordingly. Those who have the care of young girls, whether their own daughters or not, do not fulfil their duty to them unless they exercise supervision over them sufficient to prevent them by their ignorance incurring needless risks.

Warm clothing is particularly needed during the period. Of the kind of clothing enough has already been said, but the desirability of some flannel clothing may again be urged.

As regards food not much special direction ought to be required. In the sections on Food full explanations are entered into regarding the quantity and quality of foods necessary for the maintenance of vigorous bodily health, and the relation of these to work is discussed. But it is plain that when special demands are made on the system, as they are at each recurring menstrual period, special care needs to be taken that a due quantity of nourishment is supplied. At such a time any deficiency in quantity of food or any error in kind will become most evident and most hurtful. Often at this period women are less inclined for food when it is most needed, and are too prone to quiet any appetite that is present with cups of tea, which, while they refresh and stimulate for the moment, supply no real nutriment. Plain, simple, easily-digested food of the ordinary kind at regular intervals is very necessary. At the same time too plentiful or too rich feeding is also injurious. Rich dishes, pastries, &c., are not to be encouraged. It is also too common to attempt to relieve the feeling of depression or exhaustion by stimulants. They cannot supply the place of appropriate nourishment, and are apt to lead to bad habits. It is always those who do not take fit nourishment that are most prone to turn to stimulants, and it is always they who are most injuriously affected by alcohol, since it quickens the waste going on in the body without affording any material to supply it. As a general rule the use of stimulants is to be condemned. The circumstances that make them useful are considered in discussing scanty and excessive menstruation in the latter part of this section.

The question of exercise for girls is as important as for boys, and is discussed elsewhere. It is only necessary to say here that, during an illness, as much rest should be taken as possible, and for a day or two after the period also. Active exercise during that time is the greatest possible mistake.

Bathing is to be avoided during the illness, and in particular cold bathing.

PREGNANCY AND ITS MANAGEMENT.

Conception.—Every four weeks, as has been stated, in the adult woman an ovum becomes ripe and is discharged from the ovary. It is caught by the extremity of the fallopian tube and passed down the tube towards the womb. If the changes arising from conception do not

occur, the ovum breaks down and disappears. If, however, shortly before it leaves the ovary, or during its descent of the fallopian tube, the ovum is met by the male element, which enters into it and fertilizes it, a set of changes occurs in it which lead to the formation of a new being. The material supplied by the male consists of a thick whitish fluid, in which the microscope reveals curious bodies, represented in Fig. 186, formed of an oval part, called the head, which is about the $\frac{1}{6000}$ of an inch long, and of a tail, the $\frac{1}{400}$ of an inch in length. They are called **spermatozoa**, and they are the essential element supplied by the male for conception. The fluid having been introduced into the female in the act of sexual intercourse, the spermatozoa find their way upwards into the womb and on to the fallopian tube, partly by the lashing movements of the tail, and if in their course they meet an ovum, still in fit condition, one or more spermatozoa entering it produce conception. Among the earliest changes that thereafter occur in the ovum is one by which, from the original single cell, a mass of cells is produced. Fig. 187 shows at 4 ova, magnified. Soon after the entrance of the spermatozoa the

Fig. 186.—Spermatozoa, the male element in conception.

Fig. 187.—First changes in the Ovum after conception
1, 2, and 3 are enormously magnified; 4, less so.

ovum divides into two (1 of fig.); each of these two then subdivides into two, making four (2 of fig.); each of the four subdivides, so that eight are formed, and the process goes on to sixteen, thirty-two, sixty-four, &c., until a mulberry-shaped mass of cells (3) is formed, all derived from the original single cell or ovum. This process is supposed to occupy about eight days, and to occur while yet the ovum is descending the fallopian tube, and about the end of that time it reaches the womb, which has meanwhile been prepared for its reception, and where it is detained till the new being is more fully formed. It is from the mass of cells thus produced that the body of the child is gradually developed.

While conception is more likely to result from connection shortly before or within a few days after an "illness," there is really no period at which intercourse may be had and conception not be possible.

The Growth of the Offspring.—When the ovum which has been fertilized by the action of the male element reaches the womb it is not much larger than its original size, about the $\frac{1}{120}$ of an inch. It becomes attached to the walls of the womb in a peculiar way. Before its arrival changes take place in the inner lining membrane of the womb, causing that lining to become much increased in thickness, and owing to the increased thickness the surface is thrown into ridges and furrows. The small ovum apparently is detained in the womb by falling into one of these depressions, and becoming buried, as it were, by the ridges of the thickened wall growing round and over it. About the third or fourth week after conception the ovum has become completely imbedded in the wall, in which it forms a little swelling. Meanwhile by this time the surface of the ovum is not smooth and regular as it originally was, but is

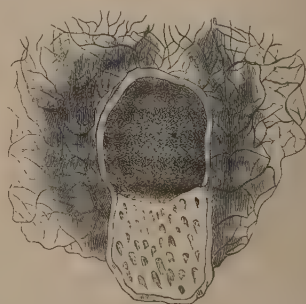


Fig. 188.—Attachment of the Ovum to part of the wall of the Womb. Part of the membranes covering over the front of the ovum has been turned down.

covered by a set of shaggy projections, termed villi. These villi are the result of changes going on rapidly within the ovum. They become imbedded in the substance of the wall of the

womb, which completely surrounds the ovum, and thus an intimate connection is effected between the body of the mother and the growing offspring. At this period the condition of things is represented in Fig. 188, where the ovum with the shaggy projections of its own lining membrane is shown resting on the wall of the womb, which has grown up around it so as completely to surround and cover it. The ovum is thus shut up in a little chamber in the wall of the womb, and is shut off from the cavity of that organ.

In the early period of its formation the new being is called an **embryo**, and in the later period before birth it is called a **fœtus**.

It is evident from Fig. 188 that as the embryo grows the swelling in the wall of the womb will grow larger and larger, and will gradually encroach on the space belonging to the cavity of the womb, until at length, with increased growth, the part of the wall which covers over the embryo will bulge right across to the opposite side, will, in fact, come into contact all round with the rest of the wall of the womb, and will become merged into it. This happens after the second month of pregnancy. The shaggy projections, that have been mentioned as growing out from the wall of the ovum, undergo increased growth at that part of the ovum opposite to the part of the womb on which it rests, and at that place blood-vessels come to occupy their interior. At other parts of the ovum they shrink and disappear.

Formation of Membranes and After-birth.—That part of the wall of the womb on which the ovum rests undergoes special development, and as the result of the special growth on the part of both the womb and ovum at that place, a special structure is formed, called the **placenta**, by which the structures of the embryo and those of the mother come into intimate relationship, and in which the blood belonging to each comes into such close contact that exchanges of material can take place between them. It is by means of the placenta that the nourishment of the growing offspring is obtained, it being a bond of union between offspring and mother, the agent through which nourishment is conveyed from the blood of the mother to the child. The placenta is also called the **after-birth**, from the fact that after the birth of the child it is separated and expelled from the womb. By the end of pregnancy it forms a disc-like mass, measuring 7½ inches across, ¾ inch thick, and about 20 ounces in weight. Connected with it near the middle is the **umbilical cord**, by means of which the growing embryo is attached to the placenta. Running within the cord are two arteries which carry the blood *from* the embryo to the placenta. In the placenta the blood is distributed in large spaces, and comes into close communication with the blood of the mother, by means of which its purity and nourishing qualities are maintained. From the placenta the blood passes back along the cord in a vein to the embryo, to which it gives up the requisite supply of material for continued life and growth.

To return to the ovum. We have seen that after conception it divides into two cells, then into four, and so on, till a mass of cells is produced, which dispose themselves in such a way that a hollow sphere is formed. It is from the outer layer of this sphere that the shaggy projections are thrown out which become connected with the part of the wall of the womb that has covered over the ovum, forming an outer membrane. On a part of the sphere the embryo begins to develop, and as it grows the parts of the sphere beyond the place where it is developing rise up round it, and finally meet and close over it. Thus the embryo comes to be inclosed within a membranous sac of its own, called the **amnion**, while it maintains its connection with the parts beyond by a cord, the umbilical cord. As the embryo grows, fluid is formed within the sac, and thus the embryo as early as the second month is floating in fluid contained within a sac, and connected with the wall of the mother's womb by means of a cord and the placenta. With further accumulation of fluid the amnion enlarges till it comes into contact with the outer membrane already mentioned, with which it becomes fused. So in the later stages of pregnancy the fœtus is freely movable in a mass of liquid contained within a large sac formed of the blended membranes, and is suspended in the liquid by the cord, the other end of which is attached to the placenta, which is in close connection with the wall of the womb, the womb itself being completely filled by the sac and its contents. In the course of labour the membranes are ruptured and the liquid escapes, in common talk "the waters break."

Progress of Growth at different months.—In the course of the third month of pregnancy the ovum, with its growing embryo inclosed within its membranes and floating in the fluid, comes to occupy the whole cavity of the womb. As the embryo continues growing the womb must needs enlarge with it.

After the end of the third month of preg-

nancy the growing offspring is now called a fœtus, and is so called till birth takes place. At this time the fœtus measures from 5 to 6 inches in length, and weighs about 4 ounces. Already at this time the sex is distinct, the outline of the body is complete, the eyes and ears are formed, and the nails have commenced to form.

At the end of the fourth month the fœtus has increased to 7 inches in length and nearly 9 ounces in weight. A slight down, instead of hair, begins to appear on the scalp and surface of the body, and brisk movements occur, though they may not yet be felt by the mother.

With the end of the fifth month the length has increased to from 8 to 10 inches and the weight from 10 to 12 ounces. Early in the fifth month the first movement is usually detected by the mother, and this is called the period of quickening, though, as has already been said, this is only the time when the mother feels the movement, which has previously occurred unperceived by her.

At six months the growing child is 11 to 12½ inches long and weighs more than a pound. The nails are solid, and eyebrows and eyelashes have begun to form.

In the course of the seventh month the length increases to from 12½ to 14 inches, and the weight is considerably increased by deposit of fat under the skin. In the male child the testicles begin to descend from the cavity of the belly towards their proper position.

By the end of the eighth month the length of the child is usually about 17 inches, and the weight 4 to 5½ pounds. The skin is red and covered with down. In the male child one testicle has completely descended, usually that of the left side.

At birth the average length is from 19 to 24 inches, and the average weight 7 pounds.

Male children are usually larger than female children. While 7 pounds is an average weight there are many variations. 5½ to 6 pounds weight means a very small child, and 12 to 13 a very large child, but such extremes are now and again met with.

The Duration of Human Pregnancy.—The average duration of pregnancy is between 274 and 280 days, or about forty weeks. It is roughly counted as nine calendar months. This period should be estimated from the time of conception to the time of birth. But the time of conception, that is, the time when the male element meets the ovum and enters into it, it is impossible to learn, for the period of conception is not necessarily the same as the period of sexual intercourse. The ovum may be fertilized even before it has left the ovary, or in any part of its course down the fallopian tube before reaching the womb. Conception may not take place thus for several days after intercourse, or it may take place shortly after intercourse, according to the distance the spermatic fluid has to travel before reaching the ovum. The time is, therefore, dated from the end of the last monthly illness, and the usual course is to count 280 days from the last day of the last illness. Conception is believed usually to occur about a week after the end of the last illness; the duration of pregnancy is counted as nine calendar months, so that the time of confinement as likely to occur nine months and one week from the last day of the last illness, that is about 280 days. This supplies a ready method of counting. From the last day of the last illness reckon nine months forwards, and add seven days. Thus, a woman ceased to be ill on the 7th January; nine months forwards gives the 7th October, and adding seven days, we have the 14th October, as the probable date of delivery. A shorter method is to count three months back instead of nine months forwards, and then add the seven days. Thus three months back from 7th January is, of course, 7th October, and seven days gives 14th October as before. As another example, suppose the 10th February to be the last day of the last illness, three months backwards gives the 10th November, and adding seven days we get November 17th as the probable date of confinement.

This method of counting is based on the fact that, as a general rule, the monthly illness ceases during pregnancy. But the ovum that becomes fertilized may not be the one whose ripening was at the time of the last monthly illness, but it may be the ovum of the succeeding month whose maturing was not attended by the monthly discharge, because conception had occurred. That is to say, conception may have occurred either within a few days after the last illness, or immediately before the succeeding illness was due. This gives a difference of three weeks. If, then, one has accurately known the last day of the last monthly illness, and has properly counted 280 days (or nine months and seven days) from that time, and if the confinement does not occur within a week after the estimated date, it may be expected not to take place for an additional fortnight, that is altogether three weeks after the originally fixed date.

While 280 days have been mentioned as the ordinary duration of human pregnancy, there is good reason for believing that very considerable variation in the length of time may occur, and yet the pregnancy be a perfectly natural one. Cases are on record where the only possible conclusion was that pregnancy had extended to 295 days. In Scotch law and according to the French Code the utmost limit is 300 days.

Signs of Pregnancy.—It may at the very outset be observed that up to the fourth month it is not possible to obtain any certain sign of pregnancy. Indeed, it may be said that the eighteenth week is about the earliest time when any really reliable evidence can be procured. It is possible for experienced persons to be deceived even long past that period, and women who have already borne children are occasionally themselves under the delusion that they are with child up to a time very close on that at which confinement would be expected. At the same time there are signs present very early in the course of pregnancy that, in ordinary cases, are accepted as sufficiently conclusive, which, however, ought not to be taken as satisfactory evidence against a woman protesting against such a conclusion. These early signs are:

stoppage of the monthly illness,
morning sickness, and
changes in the breasts.

Stoppage of the monthly illness (*cessation of menstruation*) is usually the first sign of pregnancy, for as a general rule throughout pregnancy there is no discharge whatever. There is, however, a number of cases in which the monthly illness does not cease immediately after conception, but goes on for a month or two thereafter, creating some doubt in the woman's mind as to the period of conception. In a smaller number of cases the illness occurs, almost as usual, up to even the fifth or sixth month, and in much fewer cases seems to occur regularly throughout the pregnancy. Some doubt may be occasioned in such cases, as has been already said. It is, however, much more important to remember that the monthly illness may cease for many reasons totally unconnected with pregnancy. It is quite common for the illness to become very irregular, to recur at long intervals, or to cease altogether for many months in young persons, as an effect of a depressed general system, or of some disturbance of health totally unconnected with the generative organs. Various disorders of the generative organs also cause interruption of the periodic illness for long periods. While, therefore, cessation of the illness in a married woman will quite properly lead one to suspect the occurrence of pregnancy and to seek for further evidence, it would be grossly improper on account of this alone to suspect anything of the kind in the unmarried. Unfortunately this has too often been done most unjustly and with most unhappy results. Such a sign as this must not be interpreted by itself. For instance it has happened that while, as regards the womb itself the illness has occurred, the discharge has not found an outlet owing to some obstruction of the passages. The discharge has been pent up within the cavity of the womb; and this has gone on month after month, the material accumulating within the womb and producing enlargement, and when it has gone on long enough the appearance of swelling of the abdomen. Such swelling, taken with no appearance of monthly illness, has seemed conclusive evidence of pregnancy, with grievous results to innocent persons. By itself then this suppression of monthly illness is not to be held as offering any sufficient evidence one way or another.

Morning sickness is another common occurrence early in pregnancy, but like the former it is not constant, nor yet is it reliable. It is specially in the morning and early part of the day that the sickness is felt, hence the phrase "morning sickness," and it wears off as the day advances. The feeling of sickness is generally accompanied by vomiting. It is commonest in the first months of pregnancy, beginning about the fourth or fifth week, and often disappears after the womb begins to rise up into the cavity of the belly, that is in the course of the fourth month; but it occasionally lasts through the whole nine months, producing much distress and great exhaustion. After the few early months it may disappear to return during the last months, owing probably to local irritation of the stomach caused by the proximity of the much-enlarged womb. Many mothers hardly suffer from it at all. Others are not afflicted with sickness, but with other kinds of digestive trouble, heartburn specially, water-brash, flatulence, acid indigestion, and so on. Different persons are affected in this respect in different ways, and even as regards the same person the course of one pregnancy may be very different from that of another. One curious form of digestive disturbance is the aversion that may arise for certain foods formerly enjoyed, and

the craving for others of an unwholesome, and in some cases, even loathsome character.

Changes in the breasts begin in the early weeks, and are at first feelings of fulness and tenderness, and sometimes even of sharp pain. The breasts feel firmer to the touch also, and the veins of the skin over them are more marked. About the ninth week the nipple is more erect and prominent from the greater supply of blood. Around the nipple is a dark circle, called the areola. After the ninth week the colour of this areola deepens, and the areola itself becomes larger; the little elevated points present in the ordinary condition of the breast become more prominent and marked. These appearances are always much more pronounced in dark than in fair women. In dark women also about the fifth month an outer circle of faint colour may be perceived, called the secondary areola, which has been described as presenting the appearance produced on a dingy white, or tinted surface, by drops of water falling on it, and taking out the colour. The deepening of colour is due to the deposit of an additional quantity of pigment in the deep layer of the skin, and since the deposit is more or less permanent the change is most marked in first pregnancies. Increased darkness of colour also occurs in a line about a quarter of an inch broad along the middle line of the belly from the navel downwards. In some women also patches of a yellowish-brown colour appear on the forehead, cheeks, breast and neck, which, however, disappear shortly after the birth of the child.

These signs, then, of suppression of the monthly discharge, morning sickness, and similar digestive disturbances, and changes occurring in the breasts are the earliest indications of the pregnant state. Not one of them, however, taken alone is to be regarded as offering satisfactory proof of that condition, but all taken together, while not affording conclusive proof, are to be regarded as very strong presumption of such an occurrence.

Among the later signs of pregnancy are—

enlargement of the abdomen,
movements of the child—quickening, and
detection of the sounds of the child's heart.

Enlargement of the abdomen does not occur till towards the fourth month, when the womb begins to rise upwards from the cavity of the pelvis (p. 22) into the abdomen. In the earlier weeks the increased weight of the womb, due to its added contents, causes it to sink more deeply in the pelvis, and this produces in the second month rather a flattening of the surface of the belly. By the fourth month the womb requiring increased room has risen upwards, and may be detected above the edge of the bony ridge in front. By that time the person will be conscious of an increasing tightness of the dress, and by the end of that month the hollow round the navel is less marked than usual. A progressive increase in size occurs till at the seventh month the hollow has disappeared, and the navel is on a level with the rest of the skin, after which time it begins to extend beyond the general surface. But, as with the other signs, this one must not be considered alone, for a tumour in the belly, dropsy connected with the ovaries, discharges pent up within the womb, as already noted (p. 487), and other causes will produce enlargement, which only skilled persons can distinguish from one another. Nor yet can this sign be taken along with that of suppression of the monthly illness as conclusive evidence of pregnancy, because monthly discharges prevented from escaping will occasion both conditions.

Movements of the Child—Quickening.—A mother first becomes conscious of the movements of the child in the womb at a period, roughly stated, about the middle of pregnancy. More accurately it is from the sixteenth or seventeenth week of pregnancy onwards that the movements may be detected, and if the date be noted it affords valuable aid in determining the probable time of delivery. The period at which these movements are felt is called the **period of quickening**, because it was thought that then for the first time the child became active. In reality it is active before this, but about this time the enlarging womb comes into contact with the belly walls, and so the movement becomes sensible to the mother. The sensations are actually due to movements of the child, kicks, movements of the knees, &c., and are at first felt as feeble flutterings, which, as pregnancy advances, become more and more pronounced, till they may even occasion pain and cause the mother to cry out. By the fifth month they may be excited by pressing with the hands from the outside on the belly walls. In later stages the movement is easily visible, and one may be able to feel with the hand the outline of a knee, &c., as it passes along the wall of the womb. Now this is one of the most convincing signs of pregnancy; but it is yet possible to be in error regarding it. Rapid movements of gas in the intestine, irregular contractions of the muscles of the belly wall, heaving movements due to a bulging of the wall of a large artery (aneurism),

&c., may be mistaken for movements of a child, and have been so mistaken by women who had previously borne children. Moreover cases of what have been called "phantom tumour" have occurred, in which enlargement of the belly and the sensation of jerking movements were due to spasmodic contractions of the muscles of the walls of the belly.

The detection of the sounds of the child's heart is a sign which affords unmistakable evidence of pregnancy. The beating of the child's heart may be detected about the eighteenth week of pregnancy. It is found by placing the ear on the belly at a part midway between the navel and the bony part at the bottom of the belly and a little either to the left or right. Instead of applying the ear directly the stethoscope is commonly used. The beat is distinguished from the pulse of the mother by its rapidity. It generally ranges from 130 to 160 per minute, and is more rapid in female than in male children. The position mentioned is the one in which the sound is heard, because at this stage of pregnancy the child is usually placed head downwards, with its back forwards and to the left or right, usually to the left. Some portion of its back is thus brought into contact with the front wall of the womb, and as the womb is in contact with the belly wall the sound is conducted. The child may, however, be lying in some unusual position, so that the sound is not conducted to the place mentioned, and it may be difficult to find any part of the belly wall at which it is heard. While, therefore, the detection of the sound is conclusive evidence of the presence of a child and of its life, the non-detection must not be taken as conclusive evidence of there being no pregnancy or of the death of the child. It will, therefore, be understood that this is a sign requiring to be sought for by a skilled person.

There are other signs a physician would endeavour to find to confirm his view of the presence or absence of pregnancy, but it is needless to detail them here.

On the whole, then, it will be evident that it is not always an easy matter to settle definitely whether a person be pregnant or not. The absence of the monthly illness, the occurrence of morning sickness, of changes in the breasts, and of enlargement of the belly may lead one to entertain a strong positive opinion, and yet that opinion may be mistaken. If, however, a competent person detects with certainty the beating of the child's heart, continued doubt is not possible. This cannot, however, be detected much before the fifth month. The necessity for caution in coming to any conclusion, particularly in certain circumstances, cannot, therefore, be too strongly insisted on.

The Management of Pregnancy.—The months of pregnancy are periods of considerable anxiety and trouble to most women, and are especially so to those who pass through them for the first time. It is natural that women, pregnant for the first time, should seek advice and counsel from more experienced female friends, who are as a rule too willing to offer the results of their experience, and to impress their lessons on the mind of their less experienced friend. As a rule, however, the advice is as various as it is plentiful, and often very conflicting. It is, moreover, so often accompanied and enforced by narrations of misfortune and trouble that the mind of the receiver is often perplexed and confused, but also filled with grave fears, which she can hardly utter. Now it must not be forgotten that pregnancy is a natural process, that nature is usually sufficiently able to accomplish well her purposes, and that the vast majority of pregnancies if allowed to pursue, without meddlesome interference, their natural course end naturally, easily, and successfully. The woman, who is looking forward with some quite natural anxiety to the birth of her child, should turn a deaf ear to the tales of woe, which friends too often delight to communicate, and should endeavour to preserve a cheerful and equable frame of mind, which is the only condition justified by the facts. She ought early in the months of her pregnancy to determine who shall be her medical attendant, and if she has any doubts or misgivings, or really wishes advice on any particular point, she ought without hesitation to go to him for it. If she has made even an ordinarily good choice, she will find her doubts removed, and her mind quieted, and will have an authority, to whom the advice of her friends can be submitted, and by whom it can be, without offence to them, satisfactorily disposed of.

Much may be done by pursuing a regular method of living to make the months pass in comparative ease and comfort. To aid in accomplishing this some general directions will be given.

Food.—There is no special diet suited more than another to the pregnant state. The rule is plain nourishing food at appropriate and regular intervals. Very rich and highly-seasoned dishes are undesirable. In some cases there is

a craving for certain articles, and provided they belong to the nourishing class of foods, the yielding to the craving in moderation is not to be denied; but in a few cases the craving is for unwholesome and nauseous substances. This is to be considered as morbid, and ought to be held in restraint not only by the person herself, but also by all who surround her. Stimulants are neither necessary nor desirable in ordinary circumstances. It is not denied that they are often useful and perhaps also necessary, but the usefulness and necessity ought to be judged of by the medical attendant and not by the patient herself or her friends.

In the later months a bandage, broad in front and narrow behind, if properly fitted so as to support the womb without compressing it, will give much comfort. It should be put on while the person lies in bed on her back, and should be removed at night.

Clothing should be carefully adapted to the varying condition of the person, and should never be at any part tight fitting. Enough has already been said on the subject of corsets (p. 473), but in the pregnant condition their evils are much increased. "The Romans were so well aware of the mischief caused by compression of the waist during *gestation*, that they enacted a positive law against it; and Lycurgus, with the same view, is said to have ordained a law compelling pregnant women to wear very wide and loose clothing."

Exercise.—During the early months of pregnancy there is difficulty in taking walking exercise, because the womb sinks down lower than usual on account of its increased weight, and makes walking attended with discomfort if not actual pain. When the womb has risen upwards, owing to its requiring more space, this difficulty becomes less, and thus during the middle months of the nine, exercise is more pleasant and less fatiguing. Towards the end of pregnancy it becomes increasingly difficult because of the size and weight, and also because the joints become more lax in preparation for the period of delivery. Gentle, regular, and moderate exercise, obtained by walking, should, however, be persisted in throughout the whole period, never, however, so as to cause pain. The patient must not allow her inclination to be completely at rest so to overcome her as to prevent her obtaining the slight change and beneficial stimulus, which a short period in the open air will secure to her. In particular the desire to avoid the public gaze ought not to keep the person completely indoors for the last month or two of pregnancy as it too often practically does. Gentle carriage exercise need not be forbidden, but jolting over rough roads is plainly likely to be injurious. Lengthened shopping expeditions and such like are too frequently the cause of miscarriage during the early months as well as during the later months. While more rest is needed than in the non-pregnant state, an increased amount of rest ought not to be permitted to lead on to idle, lazy, and indolent habits.

Bathing.—Baths should be taken in moderation, extremes of heat and cold being carefully avoided.

The Breasts require some attention. Pain, swelling, and tenderness of the breasts are among the early signs of pregnancy, as we have seen, and require no special attention. But if the breasts are small and ill-developed, and the nipples pressed in as they may be by the pressure of stays, trouble after delivery may be saved by drawing them out with the aid of a breast-pump, or the ordinary breast-exhauster (Plate VIII.). Should the nipples be tender the best means of toughening them is by the use of the tannin and glycerine of the chemists. The use of alum and whisky is too apt to make them hard with a tendency to crack.

Medicine.—It is a matter of the greatest moment, for the comfort of the patient, that daily movement of the bowels be obtained. This ought if possible to be secured by diet—the use of oatmeal, fruits like figs, prunes, stewed apples, &c. Sometimes medicine is needed, and many take a dose of castor-oil at regular intervals. It is comparatively safe, though nauseous, but it often occasions "false pains" near the termination of the pregnancy. The writer is in the habit of recommending not castor-oil but Hunyadi Janos mineral water. If there is any doubt at all of obtaining daily an easy and sufficient movement of the bowels, he advises the mineral water to be taken each morning before breakfast, in the quantity the patient finds suits her, and it ought to secure a gentle motion without purging after the lapse of an hour or two. The average quantity is a claret glassful, but the patient should begin with a small wine-glassful and go up, if necessary, till the suitable quantity is found. It should be then regularly taken. It is a simple remedy, practically incapable of doing harm, and its use he has found, over and over again, to conduce greatly to the health and comfort of the patient. No other medicines should be employed without proper advice.

LABOUR AND ITS MANAGEMENT.

The Stages of Natural Labour.—Natural labour is the process by which the child is expelled from the womb and born into the world. It occurs at the end of the ninth calendar month of pregnancy, or, as has been already mentioned, about 280 days after conception. It probably begins at the time when a monthly illness would have been due, counting such illness as recurring every twenty-eight days, that is to say, at the time when the tenth monthly illness from the time of conception would have become due. As we have seen, the womb is composed largely of muscle. As pregnancy advances it becomes greatly enlarged to make room for the growing child. Its walls also become greatly increased in thickness, and the muscular fibres become increased not only in number but also in size. The chief force in labour is the contraction of these muscular fibres. The fibres are so arranged in the walls that when they contract and shorten they tend to diminish the size of the womb and of its cavity, and thus act in the direction of squeezing out of the womb its contents. The walls are so strong that when they contract in this way they exert a very great force, and are thus able to overcome very great resistance to the expulsion of whatever the womb contains. The amount of resistance will depend on the bulk of the contents—on the size of the child—and on the width of the passage through which the child has to pass before reaching the outside. The first resistance, however, occurs at the mouth of the womb, which is closed or at least not much wider than to admit the passage of anything thicker than an adult's finger. The child can, therefore, make little advance along the passage till the mouth of the womb has been sufficiently dilated or stretched, and this opening up or dilatation of the mouth of the womb is, accordingly, the first thing to be accomplished in the labour process. It forms **the first stage of labour.**

It has been already mentioned (p. 485) that the child is inclosed in a bag of membranes, floating in a liquid (the waters), having a cord attached at the navel by which it is connected with a mass called the placenta or afterbirth (p. 485) attached to the inner wall of the womb, by means of which union with the mother is maintained. By the contraction of the muscular walls the bag of membranes, with its contents of waters and child, is pressed on and forced in the direction of least resistance, that is, against the mouth of the womb. The mouth being slightly open the membranes and their contained fluid bulge into the slight opening and are a very active agent in widening it. Sometimes the mouth of the womb is rather rigid and the force pressing the membranes into it is so great that the pressure of the fluid bursts them, and a gush of water takes place—"the waters are broken," as the phrase is. The part of the child's body that is directed downwards—usually the head—is then pressed directly against the mouth of the womb, but it being larger and not able to insinuate itself into the small opening as the bulging membranes did, dilates it much more slowly, and the labour is all the more tedious. During the first stage of labour, then, it is desirable that the membranes should remain unruptured and that the "waters" should not escape.

It is the contractions of the muscular walls of the womb that occasion the pain characteristic of labour. They are not continuous, but last only a brief period, so that there are periods of pain followed by periods of freedom from it. The intervals of rest prevent exhaustion of the muscular walls and also of the mother, and at the same time permit the mouth of the womb to be gradually and gently opened up without risk of injury, while the child also is allowed an interval to recover from the compression which, in the later stage of labour, each contraction exerts on it. The pains during this first stage are of a cutting or grinding character, and are usually trying to the mother, because she feels as if no progress were being made by them. She is often, on this account, irritable and restless under them, frequently changing her position and uttering complaints. A considerable interval elapses between each pain in this stage, perhaps twenty or thirty minutes at first, but the interval gradually lessens as the opening up of the womb becomes more nearly sufficient, till towards the end of this stage they may be returning every five minutes or oftener. The pain is usually felt more in front. While this stage lasts efforts of straining or pressing downwards do not render any assistance in opening up the mouth of the womb, and they ought not to be encouraged, since they throw away the patient's strength, which ought rather to be reserved for the second stage, when they are of great value. It is of advantage, however, for the patient to move about her room, and interest herself in some gentle occupation during the intervals of rest, rather than confine herself to bed.

The second stage of labour begins when the mouth of the womb is sufficiently widened to permit each contraction of the womb—each pain—to urge the child through the opening and down the passage to the outside, and it ends with the birth of the child. During this stage the bag of fluid is no longer a help, but rather a hinderance, and, therefore, it is proper for the attendant to introduce a finger into the passage, and when a pain occurs to press the point against the bulging and stretched part so as to burst through it. This permits the escape of the water and allows the advancing part of the child to come directly into contact with the walls of the passage, which it is best able to stretch. The upper and inner end of the passage is formed of the bony rim of the pelvis and is practically unyielding, so that the child in advancing through it must have its body compressed and moulded to permit of its passage. Were the pains constant the continued compression might be injurious to the child, and so the intervals of rest, though brief, are beneficial. The remainder of the canal is formed of soft and yielding structures, which the advancing part of the child stretches with more or less ease. But here again the periods of contraction, followed by intervals of rest, permit the parts to be stretched to some extent and then to be released from pressure. Thus the widening of the passage is accomplished gradually and without risk of injury.

During the second stage the patient naturally fixes her body, bends the knees up towards the body and the head towards the chest, grasps something fixed with the hands, and holding her breath presses down. The pressure thus exerted by the walls of the belly greatly aids the process of delivery. During this period, therefore, the patient remains in bed, and the more quietly she lies, the more firmly she holds her breath, while the pain lasts, and the more vigorously she presses down, the more speedy will be the termination of her suffering. In a few cases, when the child is advancing with great rapidity, and the parts are being stretched too quickly and forcibly for safety, one does not permit the patient to have anything to grasp, and, instead of urging her to hold her breath and press down, one asks her to cry out, to refrain as much as possible from pressing down, and thereby to prevent the pressure by the walls of the belly. The pains during the second stage are felt at the back, and the patient is much aided by some one pressing the back firmly with the palm of one or both hands. Towards the termination the mother feels something pressing low down, and the bulging and opening out of the external parts indicate the near approach of delivery. The advancing part of the child appears at the external opening, which it widens as the pain occurs. With the interval of rest it retreats. When another pain occurs it advances further, stretches the opening still more, and with another interval again retreats. The child may seem just about to be born, when the pain ceases for a minute or two, and it goes back again. This sometimes disheartens a mother somewhat, but it is desirable, for it permits the gradual widening of the opening, and diminishes the risk of tearing. Finally, with a great effort the first part of the child is born, the rest of its body quickly follows, and the delivery of the child is accomplished.

The third stage of labour, however, remains. It consists in the expulsion of the after-birth, with which the cord passing from the child's navel is connected, and it is usually unaccompanied by much pain, and occurs within from five to thirty minutes of the birth of the child. It is often expelled from the womb when the child is born, and lies in the passage for a little time, till it is removed by gentle pulling on the cord by the attendant, or ejected by contractions of the walls of the passage itself.

The after-birth is separated from the wall of the womb by its contractions. But with its separation blood-vessels of the mother are opened and a raw surface is left. From this for an instant blood escapes, in considerable quantity, but is speedily checked by the contraction of the womb, which now becomes permanent, squeezing the mouths of the bleeding vessels together and thus closing them. Some blood remains in the cavity of the womb, which is reduced by the contraction to very small dimensions. It gradually oozes away as discharge. Any clots that remain do not escape so readily, and excite small contractions to get rid of them. These are the occasion of the **after-pains.** So that the more thoroughly the womb is emptied of all clots after the separation of the after-birth, the fewer will be the after-pains; and they will be severe and troublesome for a day or two if any quantity of clots has remained behind. Usually after-pains are absent in a first labour.

The Duration of Labour varies naturally with the size of the child and the width and capacity of the canal through which it must

pass, as well as with the age, vigour, and build of the patient. It is longer in first labours than in those subsequent, on an average twice the length. The average for first labours is roughly twelve hours, and for others six. The first stage occupies generally two-thirds of the whole time. At the same time it is not possible to gauge what is likely to be the time occupied during the later stages from that occupied by the first. For a labour which has begun quickly and gone on quickly for some time may become much slower as its termination approaches, or the reverse may occur.

The Position of the Child in Labour.—In the womb even in the early months of pregnancy the child usually bends forwards, and in the later months the head is bent forwards upon the chest, and the thighs bent upwards to the belly, the knees and elbows also, and the arms crossed and folded over the breast. This is called the **attitude of the child**, and it suits best the cavity in which it is placed.

It is usually the head that is directed downwards towards the mouth of the womb. At full time this is the rule in 96 per cent of cases. But other parts of the child may present themselves first at the mouth of the womb, and the word **presentation** is used in referring to the part of the child that thus offers itself first at the opening of the womb. Thus there are head presentations as already mentioned occurring in 96 out of every 100 cases. The other extremity of the oval which the child forms in the womb may, however, be first, and thus there are said to be breech presentations, in which the buttocks present first. This occurs once in every 45 births. The child may be across the mouth of the womb—a cross or transverse presentation—and so a shoulder or hand, &c., descends first. These are happily rare, for they are very unfavourable.

Usually the head descends first, with the face directed backwards and to the right side, and when it has advanced a considerable way it turns slightly so as to make the face look directly backwards, and directed thus the child is born, the back of the head passing outwards and upwards in front of the mother, the face sweeping round the back wall of the passage. When the head has been born the face turns upwards towards the mother's right thigh, and this movement allows the shoulders to descend in the direction of the canal in which there is greatest room. As soon as they have been born, one in advance of the other, the birth of the rest is easy. In its descent along the canal the child's head is moulded more or less in proportion to the difficulty of the labour, so that when born it has a peculiar elongated appearance, which gradually passes off in the course of a few days.

The Management of Labour.—Labour is a natural process, and in the vast majority of cases is best accomplished by nature's own unaided efforts, without any necessity of meddlesome interference. It is only now and again that interference is necessary or desirable. As, however, in nearly every case where interference is necessary, there is a particular period when it may be more easily and successfully employed than at another, a woman in labour ought to have from the beginning the services of a skilled attendant. If on examination he finds everything going on properly and naturally, it is a great comfort and encouragement to the patient to be told so, and if, on the other hand, he finds something that requires active interference, he can choose the best time for it, and is ready for the emergency. It cannot, however, be too strongly stated that the cases where interference is really necessary are not so common as is supposed, are indeed rare in proportion to the natural and unaided births.

The woman should be in a quiet airy room, with a fire burning in the grate, and with all proper conveniences at hand. Her companions should be few, and cheerful. Of all the plagues of a lying-in room that woman is the worst, who beguiles the hours of waiting by relating her experiences, and recalling all the horrors and misfortunes of which she has heard as attending the termination of pregnancy.

The bed should be prepared in the usual way. On the top of the under sheet is then placed a square of waterproof, in the place over which the patient's hips will be as she lies in bed; above the waterproof is a blanket folded into a square of sufficient size. Or the blanket may be folded so as to be of greater length than breadth, and is so placed that as one part gets soiled it may be drawn forwards from below the patient and a fresh portion thus brought under her. It is well also to have a square of waterproof *below* the under sheet. On a screen before the fire is hung, ready folded, another blanket to replace the soiled one when it is withdrawn, and also a sheet similarly folded. In the first stage of labour it is well to allow the woman to be up, and moving about or occupying herself between the intervals of pain. When the second

stage comes on, she should get into bed, lying on the left side with the knees drawn up and fixed by means of the feet pressing against a stool or such contrivance, while the upper part of the body is fixed by the patient tightly grasping a towel fastened to something at the head of the bed. The strong downward pressure the woman can thus exert is of great value in the second stage, though it is only a waste of strength in the first. The patient should have on the clean clothing she means to wear during her confinement to bed, but it should all be well gathered up above the waist out of the way of discharges, and lightly fastened round the waist should be a petticoat which will protect the clothing to some extent, and be easily slipped off over the feet, when the labour is over.

At the commencement of labour, if the bowels have not been properly moved for some time before, it is well to clear them out by means of an enema injection.

During the labour drink, cold water, &c., is not to be refused, but, of course, ought to be partaken of only in moderate quantities. A warm cup of tea may be refreshing, but stimulants are to be given only by medical orders, and without such advice no drugs should be taken with the idea of terminating the confinement more quickly.

Just when the child is being born the patient should refrain as much as possible from severe pressing down, that the risk of tearing the parts may be diminished. It appears also that the common custom of placing the hand over the external parts to hold against the advancing head is more likely to lead to rupture than to prevent it.

In anticipation of the birth of the child, its clothing should be hanging before the fire, a bath, warm water, a clean sponge, and some good soap should be in readiness, also a pair of scissors, and two pieces of linen thread, each piece about a yard long, and twice doubled with a good knot at each end, for the purpose of tying the cord. Some olive-oil should also be at hand. As soon as the head is born the attendant should pass the fingers up to feel whether the cord is round the neck. If it be, the finger should be able easily to slip it over the shoulder. One hand is then placed over the outside of the belly, and grasping the womb, as it were, gentle pressure is to be made following it downwards as it descends. The body of the child will usually be born within a few seconds of the head without any further aid, though gentle pulling may be made with one hand on each side of the head, if aid seems needed from threatened suffocation of the child or other cause. Rarely the membranes are not ruptured during labour, and the child is born still inclosed in them. They must in such a case be quickly torn, else the child will be suffocated. The child is said in such circumstances to be born with a "caul." This, of old, was considered a sign of good omen, and seamen used to seek to obtain the caul under the belief that it protected the wearer from death by drowning.

The Treatment of the Newly-born Child.—As soon as the child is born it should be placed in a position in which it may breathe easily, bed-clothes being kept off its face, &c., and mucus wiped from the mouth and nostrils with a clean napkin. Usually the mere contact of its naked body with the air causes a gasping movement followed by regular breathing and lusty crying. If this does not at once occur, it is ordinarily readily induced by suddenly blowing in the child's face, smartly patting it on the buttocks, rapidly rubbing the fingers up and down the sides of the chest, or dashing a small quantity of cold water on the chest. All these means, by irritating the nerves of the skin, stimulate the movements of breathing. In the meantime it is proper not to tie the cord or separate the child from its attachment to the mother. For if the fingers be placed on the cord pulsation will often still be felt, indicating that the circulation in the after-birth has not yet ceased, and there is thus the possibility that the child's blood may still be aerated to some extent through the mother. If the pulsation has stopped, and the child's breathing is not yet established, the cord should be tied, and then divided, and the child's body should be quickly plunged into a basin of warm water, the head of course being supported, and then as quickly removed from it, and cold water plentifully dashed over the chest, then plunged again into the hot water and again the cold dashed over it, till by the sudden changes the breathing is established. If these methods do not speedily produce the desired effect, artificial respiration must be resorted to. The little finger (quite clean) of the attendant should be introduced into the mouth and passed to the back of the throat to sweep out any mucus there. Then one of two methods may be adopted. Dr. Howard, of New York, advises that the child be supported on the attendant's left hand and

arm (as shown in Fig. 189), while the right hand grasps the lower part of the chest. The chest is steadily compressed for three seconds, and then suddenly let go. After waiting for

Fig. 189.—Howard's Method of causing breathing in the newly born.

three seconds the pressure is repeated, and so on, ten to twelve times a minute. The second method consists in the attendant, after cleaning the child's mouth, applying his or her own mouth closely to it, and the child's nostrils being closed, gently and steadily blowing till the chest is seen to be inflated. On allowing the nostrils to open the chest will fall again; they should be again closed, and the blowing repeated. This should be continued for a considerable time, at the rate of ten to fifteen times a minute, and if any effort to breathe be made by the child itself the blowing should be timed to aid it.

In ordinary circumstances little effort is needed to excite breathing beyond the slapping, &c., already noted. All that remains to be done, then, is to tie and cut the cord. This is done in the following way. Two pieces of linen thread folded twice, each with a large knot at both ends, are used. One piece is tied tightly round the cord about 1½ inches from the belly, and the other piece an inch further away. The cord is then divided *between the two pieces of thread.* Care must be taken that, in the act of tying, the cord is not suddenly jerked, lest it be torn from its attachment to the belly, which would occasion bleeding very difficult to stop. Further, while the cord is being divided, care must be taken lest the child by a sudden twist brings fingers, toes, or other part between the scissors. As soon as the child is separated from the mother, it is handed over to be washed. This process should be done quickly with warm water, a clean sponge and *a little* good soap. Every part of the body, but especially wherever there are folds of the skin, must be carefully washed, then thoroughly dried, and afterwards *lightly* dusted. Sometimes parts of the body are covered with a white material which soap and water will not remove. Let the nurse rub such parts with oil, lard, or butter till a kind of lather is produced, and then washing will readily remove it.

After the washing the stump of the cord must be dressed. A square piece of linen is employed, the stump is passed through a hole cut in the middle, and the linen is then folded over from above and below, and from each side. It is then *lightly not tightly* secured by the binder. The clothing suitable for the child is given in detail on p. 444, and its feeding on p. 438. It must receive no sugar and water, nor any food except the breast milk.

The Treatment of the Mother after the birth of the child. The first thing requiring attention after the removal of the child is the removal of the after-birth. If the hand has been pressing down on the womb from the outside during the birth of the child, this will probably have aided the separation of the after-birth. The hand is to be again applied on the belly over the womb, which ought to be felt as a firm roundish mass, and if the womb be grasped and gently but firmly pressed downwards and backwards, a slight rubbing movement being at the same time practised, the womb will usually be found to grow smaller and firmer, and to descend. The hand must follow it, the firm pressure being continued, when the after-birth will be readily expelled. *The after-birth is not to be removed by pulling on the cord,* only a gentle pull is to be exerted on it, if the womb is contracted, and merely to aid its expulsion, not forcibly to draw it out. When it appears at the external opening it is to be taken into the grasp of the hand and twisted round and round a considerable number of times. This coils the membranes, expelled with it, into a sort of rope, and prevents any part of them being retained in the womb, to give rise to severe after-pains. After the removal of the after-birth, the hand should be kept pressing on the womb for a little time, and if it show signs of relaxing to any extent by growing larger and rising up into the belly again, slight rubbing will cause renewed contraction, and in a short time it will remain firmly contracted.

The petticoat or other garment which has been round the woman's hips must now be slipped over the legs and pulled out along with the soiled blanket, &c., from under the patient, who meanwhile remains lying on her back, exerting herself as little as possible. A folded and warmed napkin is placed between the legs

to absorb the discharge, the clean warm blanket within a folded sheet is pushed under her, and a bandage applied round the waist. The bandage should be shaped to fit her body and should be fastened with safety-pins in front, a pad of a couple of folded napkins being placed beneath it and over the womb. The bandage is to be fastened with a moderate degree of tightness, and adds much to the person's comfort. The clothing and bed-clothes are now adjusted and the patient left to rest, the head being low.

Soon after the mother has been made comfortable she may have a warm drink, cup of warm tea or such simple drink, *but no stimulant.* It is well as soon as the child is dressed to put it to the breast, if the mother is not too tired, for a few minutes. The contact of the child's mouth with the breast gently stimulates the contraction of the womb, and tends to prevent relaxation of the womb and bleeding. Regularly every third hour thereafter the child must be replaced at the breast (see p. 438), whether there be milk or not. The effort at sucking promotes the production of milk.

If the mother be thirsty a small quantity of cold water or milk is not to be denied her, but only a small quantity is to be allowed. After the first application of the child the woman needs a rest. The infant should be removed to its own basket-bed, in order to permit a two or three hours sleep to its mother. When she awakes she needs food. The old practice was to give only tea and dry toast for several days after confinement, and to deny rigorously all cold drinks. This is absurd, and fortunately is only now practised by the ignorant. The mother needs good nourishing food. It should be provided her in small quantities at regular intervals of three or four hours. It may consist of boiled bread and milk, varied with beef-tea, mutton soup to which only rice and parsley have been added, about a breakfast-cupful at a time with bread, and once or twice in the twenty-four hours a cup of tea and lightly-buttered toast, if such be desired. Diet such as this, if given in moderate quantities at the three or four hours interval, will suit admirably for the first two or three days. During the night the food is also to be supplied. By the third day a soft-boiled egg, switched, and given with bread and milk, will be acceptable, or boiled white-fish, with the cup of tea, beef-tea and soup being also given as before. By the fourth day or thereby the diet may be varied with some well-cooked minced meat or a lean broiled steak or chop, with bread, and piece of chicken and so forth. Thus gradually the diet will return to what is usual, more detailed directions for which are given on pp. 439, 440. Thirst is relieved by small quantities of cold water or milk, soda-water and milk, &c.

If by the third morning after the birth the bowels have not been moved, a sufficient dose of castor-oil should be given. Thereafter, if medicine is required a wine-glassful of Hunyadi Janos mineral water given in the morning is best. Any difficulty in passing water will be relieved by the application of flannel, wrung out of hot water, over the lower part of the belly and between the legs.

Throughout this time the mother remains in bed, not being allowed to sit up for any purpose, food being given by means of a drinking-cup, and the discharges being passed into a bed-pan.

Visitors are forbidden.

Sitting up in bed is not to be allowed till the seventh day, and then only for a brief period for meals, and the patient must not be allowed out of bed at all before the tenth day, and then only for a few minutes, wrapped in blankets. A fortnight after the birth is soon enough to permit the mother to get up for any length of time with clothes on. Even by that time she should rise for say an hour in the forenoon and an hour in the evening, and each day gradually lengthen the time till after another week she spends the better portion of the afternoon out of bed. It is infinitely better for her to take a long period of rest in order to rise thoroughly recovered and with restored strength, than to get up too soon and require to take soon to bed again with full recovery impeded. Details as to the management of the period of nursing are given on pp. 438 to 448.

After-pains are of the nature of labour pains on a small scale, and are due to irregular contractions of the womb, owing to the presence of blood clots and the effort to expel them. As a rule they do not occur after a first labour, and may be greatly lessened after subsequent labours by the method of following the descent of the womb with the hand, and by the method of removing the after-birth, which have been described. They may be relieved by the application, close up between the legs, of a thick pad of flannel wrung tightly out of hot water. If they are severe a single dose of twenty drops of laudanum may be given. This is to be repeated in two or three hours, only if really necessary.

The discharge from the womb for the first

twenty-four hours after labour is of blood, and contains sometimes small clots. It gradually becomes less red, and by the third or fifth day assumes a greenish or yellowish hue. It has a peculiar odour. It gradually becomes colourless, and finally ceases by the end of two or three weeks. For the first few days the discharge is to be promoted by occasional gentle bathing of the external parts with warm water. Strict cleanliness must be observed, and clean napkins freely employed.

DISEASES OF WOMEN.

AFFECTIONS OF THE GENERATIVE ORGANS.

Diseases of the External Parts.

Eruptions, &c.—The skin in the neighbourhood of the external opening of the genital canal is liable to many of the affections common to the skin in other parts, and such affections may affect the membrane lining the entrance to the passage.

Thrush, for example, such as occurs in white patches in the mouths of children, is not infrequent. Refer to page 460. The treatment described there is to be adopted.

Herpes (p. 317) is also found. It soon disappears if kept smeared with vaseline or zinc ointment, and if cleanliness be exercised.

Inflammatory Blush (p. 313), due to irritating discharges or the rubbing of opposed surface, is to be treated by bathing with warm water, then drying carefully, and dusting with oxide of zinc powder.

Erysipelas is to be treated as advised on p. 314.

Eczema (p. 318) is usually due to irritating discharges, to dribbling of urine, and is frequently the result of diabetes (p. 303). It occurs in very fat women, who perspire freely and are not sufficiently given to frequent bathing. It may spread from the inner surface of the passage outwards over the skin, down the thighs, and up over the belly, and round to the opening of the bowel. The surface is red and leaking, crusts form owing to the drying of the discharges, and bleeding cracks are produced. The parts are extremely sore and smarting, and painfully itching. The intolerable itching causes frequent scratching, which tears the tender surface, causing it to bleed. The main part of the treatment is scrupulous cleanliness. The parts should be bathed several times a day with warm water, and some mild soap—glycerine or tar soap. Any discharge from the passage, or any other apparent cause, must, of course, be got rid of. Bathing with warm lime-water, or warm water to which a pinch of carbonate of (baking) soda is added, relieves the itching. An ointment may then be used made of oleate of zinc (60 grains) and vaseline (2 ounces), or oleate of bismuth (60 grains) and vaseline (1 ounce), or chrisma sulphur. In the absence of these the ordinary oxide of zinc ointment, made with vaseline instead of lard, will do; or a wash made of glycerine (1 ounce), borax (60 grains), and rose-water (1 ounce). Should such measures fail the person must consult a doctor, lest diabetes be at the root of the trouble, or some irritating condition of the urine.

Warts, of a soft kind usually, are found just at the opening of the passage or just within. Sometimes they exist in great numbers. They may be removed by the use of glacial acetic acid, very carefully applied. The top of the wart alone is touched, and the application is repeated daily till it disappears. The patient herself should not attempt to apply it, as she will certainly be unable to prevent the acid running on to sound skin. Besides this, the part should be frequently bathed, dried and dusted. Any discharge should be treated.

Growths, called **tubercles**, much larger than warts, also occur. They require skilled treatment.

Sensitive Red Patches are occasionally found just within the entrance of the passage. They may be associated with small, red, sensitive growths round the opening of the urinary passage. They occur about the time of the change of life; they occasion much distress, and are very difficult of treatment. It is almost useless to mention treatment here, but any irritating discharge should be removed, if possible, and strict cleanliness should be observed. Some dry cotton wool inserted just within the passage will make walking more easy, and at bed-time a plug of wool, soaked in a solution made of equal parts of glycerine and neutral acetate of lead, will relieve pain. Any of the sensitive growths referred to require the aid of a surgeon for their removal.

Itching of the Genitals (*Pruritus*).—This is often a most distressing complaint. The itching is intense, accompanied by burning heat and tingling. It is commonest in women advanced in life, though it also occurs in the young. The itching is usually aggravated by warmth,

and thus the suffering is most intense shortly after the person gets warm in bed.

It is not necessarily accompanied by an eruption, though it is the companion and effect of such a disease as eczema, referred to on the preceding page; but it may exist, to begin with, without any eruption or any appearance of change in the skin whatever. But as a result of the scratching, from which the patient cannot refrain, though it is painful, cracks, scratches, &c., are produced, which bleed, and with the continual scratching may become themselves painful, and lead to the formation of scabs, crusts, &c. This, however, is not the cause but the result of the itching, in this particular instance.

Treatment.—Such itching as has been described is not to be regarded as a disease in itself. It is to be looked on rather as a sign of disease, and its true cause must be searched for and found, if it is to be satisfactorily treated.

A common cause is diabetes (p. 303). The writer has seen several cases of this most annoying itching in elderly women, for which no washes or local applications afforded more than a temporary relief, and which had existed more or less for months, and in one case a couple of years, the cause of which showed itself at once on an examination of the urine, and which disappeared very soon after diabetic treatment (p. 303) was resorted to.

The presence of a constant irritation is another frequent cause. The irritation may, however, be of many varied kinds. It may arise from a discharge of whites or other discharge from the womb or genital passage, or the watery discharge of cancer; it may be due to some condition of the urine, excessive acidity, the presence of oxalates (p. 302), stone in the bladder, or worms in the bowel, or, and this is not to be overlooked, it may be the result of the work of the particular kind of louse found in this region (p. 325).

A variety of other conditions may occasion it,—a gouty or rheumatic state of body, various unhealthy states of the womb, &c. &c. Besides all these, it would appear sometimes to be due simply to a condition of over-sensitiveness of nerves of the part.

Each cause has its own appropriate method of treatment, and it will usually require the skill and patience of an educated medical man to determine what that cause is, and what the proper treatment ought to be. Without such advice, the patient should try the effect of frequent bathing, and syringing with tepid water, to which a pinch of common baking soda may be added, the parts being dried after the bathing, and then lightly dusted with white oxide of zinc powder. A lotion made of 60 grains of the acetate of lead to 2 ounces of water is very soothing, or a lotion of 1 grain of bichloride of mercury to 1 ounce of water may be tried. The latter is very poisonous, and the bottle containing it should be carefully labelled and kept out of the way, lest accidents happen from mistaking it for something else.

Inflammation round the external opening is called *Vulvitis*. It is not seldom met with in infants and young children. Want of cleanliness may be the cause, or injury, and it is not necessary to suspect contagion from the child being ill treated, though, of course, such might be the cause. The parts are red, swollen, painful, itching, and from them flows a mattery discharge. If there is much pain and redness, soothing poultices should be applied, warm bread poultices or warm poultices of boiled mashed turnips. If the parts are not acutely inflamed bathe first with lukewarm water, and then with a lotion made of 20 grains of sulphate of zinc to 10 ounces of water. A gentle purgative of calcined magnesia or effervescing citrated magnesia is useful, and good nourishing food must be given.

Boils and Abscesses form in this region. Soothing poultices must be applied, and any matter present must be removed. This requires a surgeon. Proper advice is all the more necessary, as a rupture (hernia, p. 191) occurs here in female children, and must not be mistaken for an abscess.

Diseases of the Vaginal Passage.

Inflammation extending, that is, beyond the mere entrance up into the canal, is called properly *Vaginitis*.

Its **cause** may be very various—want of cleanliness, irritation of worms which have passed up the canal from the bowel, the presence of foreign bodies, such as a pessary introduced for a displaced womb, &c. Simple exposure to cold, especially at a monthly period, seems capable of producing it. It occurs, also, in the course of diseases like measles, small-pox, scarlet fever, and is more apt to be found in persons of depressed general health. Irritating injections may be its cause, and it may be the consequence of direct infection.

Symptoms.—The passage is hot and tender,

there is a sense of burning and smarting, bearing-down pain, frequent desire to make water, and pain in passing it; aching and throbbing are felt in the passage, and walking is attended with difficulty. The external parts may also be swollen and inflamed. There is also discharge, at first of clear and then of yellowish matter, which is often badly smelling. After a sharp attack the inflammation may pass off in a few days or weeks, or it may become chronic in persons whose vital powers are depressed.

Treatment.—In the period of acute inflammation the person should be kept at rest in bed; brisk saline purgatives, seidlitz-powders, or effervescing citrate of magnesia, should be given, and mild food, milk, soups, &c. *Stimulants must not be given.* Without skilled advice hot hip baths may be given, or injections of water as warm as can be comfortably borne. The injection should be given with an enema syringe (Higginson's or Davidson's, see Plate VIII.). The nozzle should be of caoutchouc, five or six inches long, and several openings should exist *round the extremity of the nozzle, not one at the very point.* The person should lie on her back, with the hips raised. The water should be injected *slowly*, and care must be taken that it escapes quite easily. From a half to one gallon of water may be used at one time, and the injection may be repeated twice or thrice daily in sharp attacks. After the injection a medicated pessary of 3 grains extract of belladonna should be pushed up into the passage and allowed to remain. It gives great relief. When the acute stage is past an injection of 30 grains sulphate of zinc to 1 pint of water is to be used. At the same time any bad state of general health requires treatment if the disease is to be got rid of.

Discharges from the passage (*Whites, Leucorrhœa*).—The lining membrane of the passage is studded with minute glands, which produce a clear thickish fluid for keeping the parts moist. Under a variety of circumstances it is so increased in amount as to appear externally as a discharge. Just as when one has cold-in-the-head, or catarrh as it is properly called, the minute glands studding the lining membrane of the nostrils pour out their discharge, which ordinarily is simply sufficient to keep the nostrils moist, and there is in consequence a "running at the nose," so, as the result of exposure to cold or damp, the genital passage may be affected with catarrh and the discharge appear. It may be thin and milky in appearance, or thick and sticky, or yellowish. Commonly it is whitish, and has, therefore, been called "the whites." Besides being the result of cold, it may occur as a symptom of depressed health, in pale delicate girls for example, as an expression of defective nourishment. It may also be a consequence of prolonged nursing. The discharge may originate, not in the passage, but in the womb itself, and may be the expression of some disorder there. In pale, weakly girls such a clear discharge may occur at the monthly periods without any discharge of blood. It will be the constant attendant of chronic inflammatory conditions of the passage.

The subject of such a chronic discharge usually complains of backache, discomfort in the lower part of the belly, and general weakness. This weakness may itself be the cause of the discharge, but the occurrence of the discharge will make the weak state of health all the worse.

Treatment ought to be directed to the cause of the disorder. In states of bad general health efforts must be made to improve the general health. For such a purpose the bowels must be regulated, preferably by such a gentle medicine as a mineral water, for example a wine-glassful of Hunyadi Janos each morning. A moderate amount of exercise should be obtained daily. Overwork of every kind is most injurious, whether in the case of the married woman who has a house and children to look after, or in that of the girl who has some business occupation in the workshop, warehouse, office, or school, or in the case of the girl going in for the higher education. Easily digested, nourishing food is essential. Change of air and sea-bathing are very valuable, and quinine and iron tonics ought to be administered. In the way of direct treatment to the parts the person should restrict herself, failing advice, to simple measures. Warm-water injections, and injections of a lotion of sulphate of zinc (2 grains of sulphate of zinc to 1 ounce of water), are useful, or injections of iron-alum of the same strength. If the discharge be irritating, an injection of a lotion containing ½ ounce of carbonate of soda (baking soda) to 1 pint of water, affords great relief. If such measures fail competent advice must be obtained. Indeed, where at all possible, such advice ought to be obtained from the commencement, as the inflammation may extend up into the womb and onwards to the ovaries, or to the bladder, and lead to very serious consequences.

Fistula implies the existence of some unusual communication between the genital passage and the lower end of the bowel on one side, or between the genital passage and the urinary bladder on the other. The former is called **recto-vaginal fistula**, and the latter **vesico-vaginal fistula.** The commonest cause of both arises in the course of labour. It may be that the rent occurs in the process of delivery, either with or without instruments, from the narrowness of the passage and the want of stretching capacity, or from the size of the child. In such cases it is commonly the partition between the genital canal and the bowel that gives way. It may result from long-delayed labour, when the head of the child becomes fixed and long-continued pressure is maintained upon some part of the walls. In such a case it is usually the division between the passage and the bladder that yields. Part of the wall has become so damaged by the pressure that some time after delivery, a day or two or a week or two, it separates and comes away as a slough, leaving an opening, through which the urine from the bladder finds its way into the passage. While the former misfortune may occur even with the most careful and skilled management, the latter is commonly the result of mismanagement, undue delay having been allowed to occur in the use of instruments or other means of hastening delivery. The same unusual communications may be opened up by the bursting of abscesses, by prolonged ulceration, by destruction of parts owing to cancerous disease, by wounds, and so on. But there are less frequent causes than those above mentioned. In the case of the opening between the bowel and passage, matters from the bowel will be passed by the genital opening, and in the case of communication with the bladder, urine will dribble away in an unusual manner. Other results follow. The presence of discharges in the genital passage foreign to it almost certainly occasions some degree of inflammation, extending to the external parts, which become inflamed and ulcerated, and occasion much misery by their constant smarting and itching.

Treatment of such conditions have become much more hopeful in recent years, due mainly to the skill of American surgeons Emmet and Marion Sims. The treatment consists in an operation for reuniting the edges of the tear. It is, of course, in cases where the rent is comparatively simple, as in those arising during childbirth, that the treatment is likely to be adopted, and not in fistulæ the result of cancerous ulceration.

Tumours and Growths of various kinds may occur in connection with the external parts of the genital organs or in connection with the genital passage. An **abscess** may form on one side of the external opening large enough to block the opening, and may appear to the unskilled as a solid growth instead of a mere collection of matter. Such might occur as a result of inflammation, or from some slight blow or bruise, or even from such a slight cause as the tearing out of a hair. In a similar situation there occurs, though rarely, a swelling due to a **rupture** (*hernia*, see p. 191), a loop of bowel passing down from the abdomen into a position similar to that which it occupies in the male. To mistake this for an abscess would be very serious indeed. It can be reduced and prevented from returning by the use of a properly fitting truss.

Cancer occasionally occurs on the external parts, in the form of skin cancer (see p. 434). Within the passage itself cancer does not often occur, unless it extend inwards from the outside, or downwards from the womb. When it is present, pain, bleeding, and a foul discharge are among its usual signs, but nothing is conclusive apart from the opinion of a competent medical man, who has made a thorough examination.

All sorts of **foreign bodies** have been found in the passage, which have been passed in accidentally or by design. It is not uncommon for a doctor to have to remove a pessary, inserted for treatment of displaced womb, which has remained there for years, forgotten by the patient, and has become almost fixed in the parts, in the end producing inflammation, discharge, &c. The removal of such bodies should be attempted only by skilled hands.

Diseases of the Womb.

Inflammation of the womb is a very wide term, embracing a variety of diseases known to medical men under special names, and requiring special treatment. It will be sufficient here to indicate the general features which the various forms of the disease have pretty much in common, and the general lines of treatment which can be safely adopted when medical aid is not readily obtainable. If reference be made to page 479 the distinction will be understood between the body of the womb and the neck

of the womb, which latter ends at the mouth, opening into the genital passage. Inflammation, then, may attack both the body and neck of the womb, or it may limit itself to one or other. Further, the womb is largely composed of muscle, but, within, it is lined with a mucous membrane, containing glands buried in it and opening on the surface (inner). The inflammation may exist mainly in the muscular walls, or it may be limited to the inner lining membrane. Thus there may be inflammation of the muscular walls of the *body* of the womb, or inflammation of the lining membrane *of the body* of the womb, and there may be inflammation of the muscular walls of the *neck* of the womb, or inflammation of the lining membrane of the *neck* of the womb.

Here are, then, four varieties of inflammation. Moreover, in each of these four cases the inflammation may be acute or chronic, and so there may be eight forms of inflammation of the womb. The symptoms, while presenting similar general features, will vary somewhat with each separate condition, and the treatment, to be thorough, ought also to vary somewhat to suit the particular case. The extreme advisability, therefore, of any one suffering from any of the symptoms of disorder of the womb, consulting a skilled medical man, ought to be sufficiently plain.

Happily the inflammation of the muscular walls, whether of body or neck of the womb, may be dismissed with the remark that they are comparatively rare. The common form, and it is, in its chronic form, extremely common, is inflammation of the lining membrane *of the neck* of the womb, and to that attention shall be confined, note being taken in the course of its description of any symptom indicating that the inflammation has spread upwards to the lining membrane *of the body* of the womb.

Symptoms.—The common symptoms of inflammation of the lining membrane of the neck of the womb, when not of an acute form, are profuse discharge of whites, some amount of pain in the small of the back, worse with standing or walking and increased at the monthly periods, and a sense of indifferent general health. If the disorder has lasted for a considerable time the patient will of necessity suffer from general debility to a greater or less extent, and will be paler than is consistent with health. Her digestion is almost certainly disturbed, and she may suffer from depression or nervousness, and a variety of pains and aches, now in one part of the body and now in another. The bowels are probably confined, and the urine is dark and thick. The discharge that appears externally may be glairy and clear, like white of egg before being boiled, or may be white or yellowish matter.

If the attack be acute there are pain and tenderness in the parts, throbbing with a feeling of bearing down, irritation of the bladder and frequent desire to pass water, and the discharge is often tinged with blood and of an offensive smell.

It is to be noted, however, that inflammation may exist for some time without pain, or any other symptom, except that of a profuse discharge of "whites."

Causes of the disease are numerous. Exposure to damp and cold, especially in those of feeble health, insufficiently nourished, and who fail to obtain sufficient exercise and fresh air, the irritation of a displaced womb, or instruments introduced into the passage to restore a displaced womb to its proper condition, the frequent use of irritating injections, and various other causes may produce it. It is excessively common in married women who have borne children, and too prolonged nursing may with them excite its occurrence. Nor must excessive intercourse and direct infection be omitted in the list of causes.

The condition of the parts is very much that of an inflamed and swollen throat. The lining membrane is swollen and congested, and the discharge proceeds from the glands which exist in it in enormous numbers, just as from a swollen and inflamed throat there proceeds excessive "defluxion."

The inflammation of the lining membrane of the body of the womb is attended by discharge similar to the other, but in greater amount, and disturbances of the monthly illness—irregularity, excess, or diminution—are more common. Marked nervous symptoms are often produced by it. The person is fretful and despondent, may suffer from frequent headache, limited to the top of the head, and from other pains resembling neuralgia, and the dragging pain in the back is very marked. But any difference in symptoms is rather one of degree than of kind.

A not uncommon cause of this condition is sudden stoppage of the monthly flow from cold and the irritation of matters retained in the womb after confinement or miscarriage.

Treatment.—What has been said about the causes of this disease is sufficient to show that there can be no rough-and-ready or "rule-of-

thumb" procedure in dealing with it. If the condition be mainly caused by a bad state of general health, it cannot be supposed that applications to the affected parts will cure it while the general bad health remains. Even though such a cause has not been at work in its production, the disease cannot have lasted any time without inducing some degree of bad health, which will stand in the way of a cure. Then if a displacement of the womb is the cause of the inflammatory process, nothing short of restoring the organ to its proper position can be expected to promote a permanent recovery. A mother who suckles her child beyond the necessary period, and suffers from some disorder of the womb, cannot expect to cure by injections what is maintained by the drain upon her system of prolonged nursing. So with other causes. Now, it would be the business of a medical man, well acquainted with such conditions, to determine the cause at work in each particular case, and to apply his treatment accordingly. It is plain, therefore, that it is really quite impossible to state any definite plan of treatment which a patient might herself adopt with good prospect of recovery from her trouble. The best advice that could be given would be to place herself under the care of a physician from whom she might confidently hope to receive skilful and conscientious treatment. At the same time it is only right to state some simple means of treatment which a patient may herself adopt, when skilled advice may be for the time beyond her reach,—some means which cannot be hurtful no matter what may be the exact cause of the disorder, and which will give some relief in most cases, and in some may be sufficient for a cure.

The first thing, then, to be done is to restore, if possible, a good measure of general health. The means to that end are, good food of sufficient quantity and easily digested, the regulation of the bowels, avoidance of overwork and excitement of any kind, a fair amount of exercise, exercise short of fatigue, and plenty of fresh air—sea-air is specially beneficial. Concerning food the mistake must not be made of living on slops, corn-flour, arrow-root, and foods of that kind mainly. Milk should bulk largely in the diet, but also other animal foods, soups, eggs, fish, and a fair daily supply of butcher meat. A great many women make a grievous mistake in avoiding as much as possible such animal foods, and half-starving themselves on sloppy diet. For the regulation of the bowels nothing is better than a wine-glassful or thereby of the Hunyadi Janos mineral water taken the first thing in the morning. Over and above this some quinine and iron tonic will be of much value in depressed states of health.

As regards applications to the affected parts one thing can be very strongly advised, namely, the use of hot water injections. To obtain the full benefit they must be given in the way to be described. The patient lies across the bed, a pillow under the back to raise the hips, the feet resting on chairs. A piece of mackintosh cloth is placed under her, and arranged to cause water to flow off into a pan at the side of the bed. The injection is given by some one assisting her. About one gallon of hot water should be used, water comfortably warm to the hand, by the thermometer about 110° Fahrenheit. An enema syringe is employed, with a nozzle of vulcanite or similar material, about 6 inches long. The end of this tube should not have a single opening at its point. It should end in a blunt form, and several openings should exist round it. The syringe being properly filled and in good working order, the nozzle is oiled and passed into the passage gently near the back wall and directed backwards. It should be passed in as far as it can easily slip, and then the water should be steadily and slowly injected. Owing to the hips being raised the passage will become filled with the hot water before any flows out, and this is what is desired by the method. At the same time care must be taken that there is no obstacle to the free escape of the water as soon as it has filled the passage. The injection should be given in this way at bed-time, every night or every second night. A little patience will render it comparatively easy, and the patient will speedily discover the ease and comfort it affords. If there is any insuperable difficulty in giving it in this way, the patient must content herself by using the enema syringe while she sits over a pan or bath, but the water should be used at the same heat and with the enema, the nozzle being passed well in. If the patient is very anxious to try some medicated injection, any of those mentioned on p. 499 may be employed, after the hot water, but their use is not to be persisted in for long periods if they fail soon to give relief.

Ulceration of the Womb is a phrase that strikes terror to the ears of most women. It used to be far too commonly employed, and is probably still. The condition which it is frequently used to signify is practically that already described. Owing to chronic swelling the

inner wall of the neck of the womb and its mouth become thickened, prominent, and too freely supplied with blood, but in the vast majority of cases to which the name is given there is no such eating away of the substance of the part as the name would imply.

The **treatment**, so far as the patient can resort to it, is such as has been described under inflammation. One other thing she may be able to do, and that is, take a little ball of cotton or lint, soak it in glycerine, and then push it up the passage as far as possible. *She must be careful to remove it next day or within two days*, and after syringing with warm water may replace it by a fresh one. If it is difficult of removal syringing will readily bring it down. A medical man would employ further treatment by directly painting the affected part with one or other of a variety of applications.

Tumours of the Womb.—Three forms of tumour of the womb are of comparatively frequent occurrence, namely, **polypus**, **fibroid** or **fibrous tumour**, and **cancer**. There is one broad distinction between the two former of these and the latter, and that is, that the two former are simple tumours, formed of overgrowth of some part of the substance of the womb, not destroying the substance and not necessarily dangerous to life; while the latter is a growth foreign to the true substance of the part, invading and destroying it, and tending inevitably to death within a comparatively limited period.

The **polypus** varies in size from that of a small pea upwards, and may be an overgrowth of the lining mucous membrane, or an overgrowth of the wall beneath the lining membrane. It projects into the cavity of the womb, being connected to its walls by a longer or shorter stalk. By its presence a polypus causes a greater determination of blood than is proper to the womb, and thus gives rise to bleeding, especially to excessive loss at the monthly periods. It also excites contractions of the womb, and so occasions painful spasms and pains in the back and loins. It may block the opening of the womb, and by causing difficulty of escape of the monthly discharge cause the illness to be attended by severe pain.

The **treatment** is surgical, and consists in the removal of the polypus.

The **fibroid tumour**, fibrous tumour, or fibromyoma, as it is also called, may occur in various situations, and may be of a great variety of size. It is a simple overgrowth of part of the wall of the womb. It may project into the cavity of the womb like a polypus, or it may project in the direction of the outer wall towards the cavity of the belly, or it may remain embedded in the substance of the wall, difficult to distinguish from simple enlargement of the womb. In size such tumours vary from that of a pea to that of a human head. They are extremely common, but may exist without giving any indication of their presence. They rarely appear before the period when the monthly illness begins. Their growth is encouraged by the regularly recurring increase in blood supply to the womb by the monthly illness, and also by the stimulus of sexual excitement. Marriage will thus tend to stimulate the growth of one already present, while the presence of one may be a cause of sterility: the fact of sterility will also encourage the growth. As a rule they cease to grow when the child-bearing period has passed, and thus if this age is reached a woman troubled with such a tumour may look for a gradual relief from its symptoms.

The **symptoms** are of two kinds: (1) those due to the mere pressure of the growth on surrounding parts, the chief of which is pain; and (2) those due to the increased blood supply to the womb which the tumour occasions, of which the chief is excessive loss of blood during the monthly illness, or a more or less continuous loss of blood.

The pain may be of a spasmodic character due to the tumour stimulating contractions of the womb, or it may be of a neuralgic form due to pressure on nerves, or it may be a dragging pain in the back and loins, a constant wearied feeling, easily increased by walking, and also by carriage exercise when the tumour is of any size. Other pressure symptoms may exist, such as confirmed constipation from pressure on the bowel, frequent desire to make water or inability to make water, or pain in making it, swelling of the legs, &c., and such symptoms are all liable to be aggravated at the monthly period owing to the increased size of the womb at that period. Then the monthly illness may be attended with great pain owing to the tumour blocking the escape of the discharge, and the presence of the tumour also occasions not unfrequently great pain during sexual intercourse.

Excessive flow of blood may not be marked in cases where the tumour is embedded in the walls of the womb or bulging towards the cavity of the belly, but is likely to be the main symptom when it bulges towards the cavity of the

womb itself. Usually it is a prominent symptom, and, as has been said, the loss of blood may not be limited to the period of the monthly illness, but may go on almost without ceasing. The loss of blood may be so excessive as to become the grave feature of the case.

Treatment.—It is to be remembered that the tumour is a simple one, in no way to be regarded with apprehension such as a cancerous tumour would excite. It may be a constant worry and cause of suffering from pain, &c., but it need not prove fatal. The loss of blood occasioned by its presence is the serious part of it, since this may threaten life, either directly or by exhaustion, or by laying the patient open to other disease from the general bad health arising from it. The object of treatment is to relieve the symptoms as much as possible till the child-bearing period is past, when a gradual cessation of the patient's trouble is likely to ensue.

The tendency to lose blood may be restrained by avoiding everything that would increase the blood supply to the womb. As much rest as possible during the monthly illness is, therefore, desirable, and if the patient be married restraint as much as possible from the exercise of sexual functions. Pregnancy might be a serious complication, though occasionally a fibroid tumour has almost or entirely disappeared after pregnancy and a successful confinement. Unmarried women should remain so if they are aware of the existence of such a tumour. Just before the monthly illness opening medicine in the form of mineral water or effervescent citrate of magnesia is beneficial, and nourishing but unstimulating diet, with avoidance of spirituous liquors, should be the rule.

If the bleeding be excessive the effort to limit it should be made by taking the liquid extract of ergot, from one half to a whole tea-spoonful in water thrice or four times daily; and if excessive loss of blood during the period has been the rule, this should be taken for a day or two before the illness begins, and for a few days after it has ceased. To relieve pain a pill of one-third of a grain of extract of Indian hemp may be occasionally taken, or 30 grains of bromide of potassium dissolved in water. Iron tonics taken during the intervals are valuable for restoring or maintaining the general health. Pain is often also relieved by the use of some support to the uterus in the form of a pessary if such can be adjusted for the purpose.

If the loss of blood be so excessive or persistent as to threaten serious consequences, a surgeon would probably propose an operation for the removal of the ovaries. The ovaries being removed, the monthly illness ceases, and thus nature's method of relieving the patient is anticipated.

Cancer of the Womb.—This disease may occur in the body of the womb or be limited to the neck (p. 479). The former case is comparatively rare. Cancer differs from fibroid and other simple tumours, in that it destroys the substance of the organ in which it is situated, spreading through it and from it to other parts, and tending also to pass to other organs. If it be removed it is liable to return. For these reasons a cancerous tumour is called malignant as opposed to simple. The womb is the commonest seat of cancer in the female, and its occurrence there is very frequent. It rarely occurs below the age of twenty years or above that of sixty, and is most frequent between forty and fifty. It has an inevitable tendency to death, and from one to two years is the average period of life after its appearance.

Its **cause** it is impossible to state. That it has a tendency to occur in families seems undeniable, and some distinguished authorities believe it occurs chiefly in women who have borne children, and in whom the neck of the womb has been torn. Such local irritation, however, may be only the exciting cause of the appearance of a tumour to which the woman was already disposed.

There are several varieties of it. It is common as an affection of the lining surface of the neck of the womb, gradually eating into and destroying the deeper parts, occasioning ulceration and thickening extending inwards.

Its **symptoms** are mainly pain, loss of blood, and discharge. The pain may not arise till the disease is far advanced, and is of a stabbing or burning kind, shooting up to the loins and down the thighs. It is generally worse at night. It is the loss of blood that often arouses suspicion. It may occur from apparently trifling causes, and though it may be slight to begin with, it becomes at length a perpetual drain upon the body. As a consequence the person comes to have a characteristic appearance, the skin becoming of a peculiar sallow or dirty yellowish colour. The discharge is watery, tinged usually with blood, extremely irritating to the skin of the external parts, and of a very offensive smell. The disease may ulcerate its way into the bladder or bowel, so that water constantly dribbles away or motions are passed from the genital passage.

The whole system becomes affected and deranged, and if death does not occur directly from loss of blood, exhaustion is frequently the consequence.

Treatment.—If the disease be detected early enough, its removal by the knife may effect a cure, or at the least will for a season stop suffering and prolong life. Many methods of cure by medicines have been praised at different times, but all have been in the end found comparatively useless.

The foul discharge may be relieved by the injection with the enema syringe of water containing 10 grains of thymol to the ounce, or of a 2½ per cent solution of carbolic acid.

To relieve pain opium in some form is the remedy. But it should be used under medical advice.

Everything possible should be done to maintain the patient's general health by plain nourishing food, the use of iron, quinine, and similar tonics, and the regulation of the bowels by such gentle medicines as a mineral water. Stimulants should be avoided as far as possible.

Displacement and Falling *(Prolapse)* **of the Womb.**—Displacements of the womb are exceedingly common, commoner than is generally supposed, frequently existing without giving rise to any marked symptoms. At the same time the displacement may give rise to many and pronounced symptoms, which no treatment does anything to relieve except that of replacing, as nearly as possible, the womb in its original position.

The womb is suspended, as it were, in the middle of the pelvic cavity (p. 22) with the bladder in front of it, and the termination of the bowel behind it. It is maintained in its position by its attachment to these organs, and by bands or ligaments of its own, and in its situation is freely movable in various directions. The upper end of the body is directed upwards and forwards, and the mouth downwards and backwards, so that, when the person is in the erect position, it may be said to incline forwards.

Now it may not be maintained at its ordinary level, but sink somewhat *downwards*, for example, because of enlargement or congestion rendering it too heavy for its supports, or because the supports have become stretched and weakened. This is called **prolapse**, and will vary in degree according as the womb sinks lower and lower. If it sink greatly the mouth of the womb may appear at the external opening, and, in very extreme cases, it may appear entirely outside, which form is called **procedentia.** It naturally will drag down with it the wall of the bladder to which it is attached in front, and the wall of the bowel to which it is attached behind. Further, instead of being inclined forwards, as in the ordinary position, it may be tilted backwards, in which case the body looks backwards and the mouth forwards, and this backward tilting also varies in amount. **Retroversion** is the name applied to this displacement. Or the womb may be *bent* backwards on itself, so that the body of it is directed backwards, the mouth maintaining pretty nearly its proper position. It is doubled on itself. This is called **retroflexion.** Again the *forward* slope may be exaggerated, so that the womb tends to lie across the cavity. This is **anteversion**; or it may be *bent forwards* on itself, which is called **anteflexion.**

The **causes** of such altered positions are numerous. Congestion, overgrowth, the presence of tumours, &c., adding to the weight of the organ, tend to displace it. A very common cause of this kind arises when a woman begins to go about too soon after a confinement. The womb has not had time to return to its natural size, and its supports, stretched and weakened by the pregnancy, are unable to bear up the unusually heavy womb, and thus it assumes an improper position. General ill-health may so diminish the vigour of the supports and diminish the tone of the womb itself as to occasion a "displacement." Further, any undue pressure may force it out of place, and if this be long continued it does not get a chance of returning to its natural place. Undoubtedly a great cause of such pressure is the undue weight of clothes and tight lacing. These diminish the size of the belly cavity by pinching in the waist. The bowels are pressed upon, and to find room press downwards on the womb, &c., forcing it out of position, and *keeping it out of position.* The pressure of a tumour in the belly may act in the same way. A tumour pressing upwards from below may also displace the womb, but in a different direction. As another example, the frequent existence of a distended bowel or overfull bladder, apt to occur in women, may occasion it. Undoubtedly falls, violent exertion and such agencies are often at work in producing such disturbances of position. In women who have borne children, the womb is often deprived of its due support from below by rupture of parts during labour, and it is then apt not to be duly maintained in proper place.

It ought, also, to be noted that a womb, dis-

placed from any cause, is liable to be the seat of congestion and other disorders, because of the disturbance to the proper circulation of blood through it which the displacement occasions, and such congestion will then tend to increase the departure from the natural situation.

Symptoms.—Unless in cases of prolapse, where the mouth of the womb appears externally, there are really no symptoms, by which a patient could decide for herself the nature of her trouble. There are likely to be many which would lead her to conclude that something was wrong with the womb, but none which would enable her to conclude what was the real nature of that something. The existence of a displacement and its kind can only be determined by a skilled medical man, after he has made an examination by introducing his finger into the passage, and thus ascertaining the position of the organ.

The symptoms that point to such uterine trouble are back-ache, pains in the loin, discharge, perhaps pain at the monthly illness. A womb displaced backwards is liable to press on the bowel and cause constipation and piles; a womb displaced forwards is more apt to give rise to bladder troubles, pain in making water, frequent desire to pass water, &c. &c. There is often discomfort or difficulty in walking. Indigestion is extremely common and persistent, and is sometimes the only result of a slight displacement. Indigestion so caused is almost certain to defy any treatment directed to it, but speedily disappears if the displacement be detected and got rid of. Sterility is common in all forms of displacement, but particularly in those in which the uterus is bent on itself, for the bend blocks the canal of the womb and prevents the passage upwards of the seminal fluid. Further, nerve troubles are in many cases the main pronounced symptoms of such disorder, which, like those of digestion, defy all treatment unless the uterine condition be attended to. Such disturbances of the nervous system are more apt to occur in young unmarried girls; and the hysterical condition into which young excitable girls are sometimes brought by such a cause is not easily overcome.

The **treatment** of such conditions is in many cases not attended with much difficulty, while in other cases it is by no means easy. In all, as a general rule, very great relief can be afforded, even though a permanent cure is not obtainable. But the treatment can only be properly undertaken by a medical man. It consists in restoring the womb to its natural position, if that is possible. Sometimes it is not possible, because of the very long duration of the displacement having caused the womb to become fixed in its altered position, or because of inflammatory adhesions binding it down. It is very often possible for the surgeon to replace the womb simply with the fingers, and more often with the aid of a long slender rod, on a handle, called a sound, the use of which, in skilled hands, ought not to be attended with any considerable pain. The second element in the treatment consists in the introduction into the passage of a small instrument, called a pessary, made commonly of vulcanite, but also of celluloid, or india-rubber, in the shape of a large ring, which is so placed as to support the womb in its restored position. The shape of the pessary varies with the kind of displacement. If it is properly adjusted, it should occasion no inconvenience whatever, the patient should, indeed, be unable to perceive its presence, and it does not require any alteration in ordinary ways of life, does not, for example, necessitate a married woman living a single life, while it remains in the passage. The third element in the treatment consists in the endeavour to restore vigour and tone to the parts, so that in course of time the pessary may be removed with some hope of the womb remaining in its restored position. Such treatment necessitates attention to the bowels, to the food, to proper exercise, fresh air, &c. Tonics will aid the endeavour. But the suitable tonic depends on circumstances to be judged by the physician.

Anyone who is wearing such a pessary ought to return from time to time to her medical attendant, and ought to see him without delay if any signs of its presence irritating the passage arise. Probably the pessary will require to remain six or eight months, but it ought not to remain longer without the medical man's sanction. Patients have been known to forget altogether the presence of the instrument, and to continue wearing it for very prolonged periods, till it became fixed, impacted by incrusted remains of discharge, urinary sediment, &c.

While the instrument is being worn, frequent use of the injection by an enema ought to be persisted in. This will not only aid in restoring the vigour of the womb and neighbouring structures, but by the constant cleanliness will prevent irritation arising from the presence of the pessary. The daily use of the injection is strongly urged. The injection had better be not of warm water only, but of warm water with some added carbolic acid, of a strength

equal to one ounce of the acid to every two and a half or three pints of water. The pessary is simply to be regarded as affording a mechanical support till the womb is restored to its natural condition.

The form of displacement most readily treated by pessaries is the backward displacement, the backward tilting of the womb, and happily this is the commonest of the displacements. The forward displacement is much less easy to treat in this way, from the difficulty of adapting an instrument to this situation. Fortunately it is not nearly so common a form.

Some cases of prolapse are readily benefited by treatment on these lines, others are extremely troublesome. Recently for the most aggravated cases of prolapse, an operation has been adopted by Dr. Alexander of Liverpool, which has yielded good results. It is not a serious operation, and by it the ligaments of the womb are pulled upon and tightened, "the slack is pulled in," so to speak, and the womb thus restored to its proper height and held there. Tonic treatment is necessary to restore a good condition of general health, so that, when the instrument is removed, the womb may keep its position by its restored vigour.

Diseases of the Ovaries.

Inflammation of the Ovaries and Ovarian Pain (*Neuralgia*).—Inflammatory diseases of the ovaries are not easily separated from similar affections of neighbouring parts. Moreover, the ovaries share in disorders of the womb and in diseases of parts in their neighbourhood, the removal of which will usually be accompanied by the cure of the ovarian disorder.

Any cause tending to induce congestion of organs in the lower part of the belly will produce congestion to a greater or less extent of the ovaries and set up symptoms specially referred to them. Thus sudden stoppage of the monthly flow is such a cause, and inflammation occurring after child-birth.

The **symptoms** that point to the ovaries are pain, sometimes excessively severe, in the region of one or both ovaries, that is about the middle of the groin. The slightest pressure in this position is very painful. In chronic cases of inflammation the pain is constant and wearing, usually worse at the period of the monthly illness. In some cases it is scarcely perceived at the periods, but returns in the middle of the interval between the periods. The pain is increased by standing, walking, and by sexual intercourse. It sometimes shoots down the thigh. The monthly illness is of an unusual kind, excessive or scanty or very painful. Various nervous pains are experienced throughout the body, and a highly nervous and hysterical condition may result from the chronic form of the disease.

In some cases the pain is neuralgic in character, and the term neuralgia of the ovaries has consequently arisen.

The **treatment** depends on the cause of the affection. It can only be said here that anything likely to excite congestion of the organs in the lower part of the belly is to be avoided. Constant standing, much use of the treadle sewing-machine, of the harmonium, &c., ought to be avoided. Good food, fresh air, sea-air, and sea-bathing are valuable. Hot water injections as advised on p. 502 may be tried. The evils of the use of laudanum or other preparation of opium, and of alcohol are very great, and the inducements to their employment many. They must be strenuously avoided.

Tumours of the Ovary (*Dropsy of the Ovary*).—While there is a variety of solid tumours of the ovary, the common tumour is one containing fluid. It is a cyst or sac, of every variety of size, some weighing as much as 30, 50, or upwards of 100 pounds. Its contents may be a watery, clear, straw-coloured fluid, or a fluid more gluey and tenacious and of varying colour. While the tumour may grow slowly, it has been stated roughly that the average duration of life after its beginning is under three years. These tumours are most common between the ages of twenty and forty years.

Symptoms.—In the early stages there may be practically no symptom, and the first indication may be the enlargement of the abdomen. The enlargement may be mistaken for pregnancy, though it is usually more or less rapid than that of pregnancy; and this mistake is more apt to be made if the monthly illness ceases or becomes scanty and irregular. As the tumour grows the patient becomes thin and exhausted, and disorders of the bowels arise increasing the exhaustion.

Treatment.—There is only one form of treatment of any value, namely removal of the tumour by surgical operation. It is an operation now attended by very great success when skilfully performed, and when undertaken in time before the patient's powers are exhausted. Withdrawing a quantity of the fluid by tapping is not now so common a method of treatment as formerly. It affords only a temporary relief,

the sac filling up again in a short time, and if frequently performed it may be a serious hindrance to the operation for removal, by causing adhesions between the walls of the sac and those of the belly cavity.

DISORDERS OF THE MONTHLY ILLNESS (*Menstruation*).

Absence of the monthly illness (*Amenorrhœa*).—Strictly speaking, the term amenorrhœa, meaning want of the monthly discharge, is only applied to those cases where the monthly illness has never appeared at any time. It is, however, also applied to cases in which the monthly illness has been present, but has after a time disappeared. This latter condition is more correctly termed **suppression of menstruation.**

It is necessary to notice this distinction, for, if a girl has reached the age when the illness might be expected, and it has not appeared, it is sometimes necessary to assure one's self that the non-appearance is not due to some obstacle to the escape of the discharge externally, the illness actually occurring, but the discharge being retained.

Absence of the illness through retention.—In the virgin condition there is a membrane, called the **hymen**, which stretches across the lower end of the genital passage. The membrane is as a rule not complete, a small opening existing in the centre, through which discharges from the womb escape. But in some cases, not frequent, the membrane is complete, and thus no discharge can escape. The obstruction may exist at the mouth of the womb itself. In such cases the symptoms of the monthly illness appear without discharge. At regular intervals pains in the back and sides occur, and with each return they increase in severity. The patient has a feeling of weight, and grows pale and sallow. The retained discharge, accumulating from month to month, causes the belly to enlarge and a tumour to appear, which undergoes regular monthly increase. The girl's friends putting the absence of discharge and the enlargement of the abdomen together suspect pregnancy, and many an innocent girl has thus come under unmerited rebuke.

It is even possible for such an obstruction to occur in some part of the womb or passage after the illness had become established, and this must always be borne in mind.

This condition is remedied by surgical interference, opening a way for the retained discharge to escape. Such cases are, however, always attended with risk.

Complete absence of monthly illness may also be due to some arrest of development of the genital organs. There are thus cases in which the ovaries or womb have been absent, or present in an undeveloped condition. In absence of the ovaries the girl does not exhibit the changes in form from girlhood to womanhood. The breasts remain small and the hips narrow, the voice is manly and harsh, and the appearance becomes masculine.

Absence of the illness through suppression, that is after the illness had become more or less regular, may arise from a variety of causes. It may depend upon a condition of general health or a poor quality of blood (see ANÆMIA, p. 234). The feeble condition of general health is often the result of over-work, over-pressure at school, improper quantity or quality of food, want of fresh air, confinement in the bad atmosphere of a crowded work-room, or of some acute disease, &c. The opposite condition of too full-bloodedness may also produce suppression of the illness. Disease is another cause, and especially consumptive disease of the lungs, disease of the kidneys, and digestive and nervous disorders. Emotion, fright or grief sometimes occasion the disturbance. The illness may be suddenly arrested by cold.

The absence from failure of general health is sufficiently evidenced by the paleness of the patient. She is wanting in energy, listless and languid. These cases are readily enough separated from those due to cold or full-bloodedness.

The **treatment** is regulated by the cause. It is sufficient to state the kind of treatment needful in the variety dependent on the general health, and that due to sudden suppression owing to cold, &c. It includes good nourishing food of a plain kind, containing a fair proportion of animal food, sweet milk, eggs, fish, fowl, beef, soups, &c. The bowels must be kept regular, a saline medicine, such as seidlitz, Hunyadi Janos mineral water, or the effervescing citrated magnesia being given, if required. Especially is it necessary to insist upon abundance of life in the open air, and moderate exercise. While overwork is extremely hurtful, the absence of some bodily or mental occupation is also injurious. Change of air and sea-bathing are strongly advised, and, to those who can afford it, a visit to some of the Continental spas is recommended, especially Kissingen, in Bavaria, Kreuznach, in Rhenish Prussia, Schwalbach, in Nassau,

Spa, in Belgium, Bourboule, in France. In England Woodhall Spa, in Lincolnshire, is recommended. Much standing, stooping, or prolonged sitting, is to be avoided. As to medicines it is impossible to state what suits every case, but tonics belong to the kind required. Iron and arsenic are particularly valuable.

The following prescription may be employed:—

Reduced Iron,	grains	36
Arseniate of Iron,	,,	$1\frac{1}{2}$
Extract of Nux Vomica,	,,	9
Sulphate of Quinine,	,,	12
Extract of Gentian,	,,	24

Mix and divide into 18 pills.

A half gradually increased to one pill is to be taken thrice daily after food.

These pills must always be taken after food, never on an empty stomach.

Further the full dose is not to be taken all at once. To begin with, let a few of the pills be divided into two, and let a half be taken after meals thrice a day for two or three days, then let a half be taken after two meals and a whole one after the principal meal, and so let the dose be increased till at the end of a week three pills daily are being taken.

It is important also to notice that the use of the pills must not be stopped suddenly but gradually, a half pill less being taken for a couple of days, then another half less, and so on till in a week their use is stopped altogether.

Arsenic is apt to disagree with some stomachs. In such cases it may be altogether left out of the pills.

While these directions have been given, it is desirable to say that no unskilled person should attempt to treat such a disorder if skilled advice is obtainable.

Sudden suppression, as may arise from cold, usually happens in full-blooded people, and is accompanied by severe pain in the back, quick pulse, feverishness, flushed face, headache, &c. Let the patient's feet and legs be placed in a hot mustard bath for half an hour. She should be then put into a warm bed with warm foot-pan, and should have frequent mild warm drinks, following a large dose of opening medicine, castor oil for example. If this is not sufficient, and the case seems urgent, fever being high, place hot mustard poultices over the lower part of the belly, and give 5 to 10 grains of Dover's powder according to age.

Irregularity or Scantiness of the Monthly Discharge, in which the discharge occurs after more than usually long intervals, or at irregular intervals, or in which it occurs regularly but in small quantity, is commonly dependent upon conditions of the general health similar to those producing absence of discharge, and is to be treated on similar lines.

Excessive Monthly Illness (*Menorrhagia and Metrorrhagia*).—The monthly illness may be excessive, because occurring too frequently. Such conditions indicate a depressed condition of general health, and are also associated with disordered states of the womb. They are not uncommon at the period of change of life. The tonic treatment recommended for absence of the illness is likely to prove beneficial.

There are, however, two special forms of excess. One of these is called simply profuse menstruation, what is meant being that the discharge is too free or lasts for too long a time, returning at the regular periods perhaps. The proper term for this is **menorrhagia**. The other form is not strictly discharge at the monthly periods, but a loss of blood occurring at other than the monthly period, at least a discharge of blood from the womb, occurring independently of the monthly period. This is called **metrorrhagia**.

The first form, that of excessive loss at the period, occurs under various circumstances. It must be observed, however, that there is no absolute quantity of discharge to be regarded as the healthy standard (see p. 482). Each woman knows what, under ordinary circumstances, she is accustomed to, and that is her standard. The excessive loss may depend upon bad conditions of health, arising from Bright's disease of the kidney, scurvy, consumption, &c. Commonly it is a symptom of chronic disease of the womb. It is sometimes the only symptom of fibroid tumour of the womb (p. 503). In cancer of the womb, polypus, displacement, congestion, and in many other alterations in structure, it is present.

The excessive loss produces a blanched appearance of the patient, and according to the degree of excess is more or less exhausting. The second form is met with under similar conditions, and the first often leads up to and merges into it.

The **treatment** of both forms is practically identical. The patient should rest in bed as much as possible during the period, undertaking no exertion. If the loss of blood is great and threatening, whether during the period or not, she must lie in bed perfectly quiet and lying on

her back. Mild but nourishing diet in small quantities should be given often—milk, light soups, &c. The very valuable and most readily obtainable drug is ergot or spurred rye, in the form of the liquid extract. A half to one teaspoonful is given in water or syrup every third hour as long as necessary. Another useful drug is the tincture of witch-hazel (*Hamamelis virginica*, p. 835), in doses of five drops in water every third or fourth hour. A medical man would, in urgent cases, plug the passage by inserting pledgets of soft cloth, sponge, silk handkerchiefs, &c. In the intervals good nourishing food, bracing air, moderate exercise, &c., are valuable, as well as the iron tonic advised for absence of the discharge on the preceding page.

In certain cases of persistently recurring attacks, due to tumours, and threatening life, a surgeon might recommend removal of the ovaries, or other operative interference.

Painful Monthly Illness (*Dysmenorrhœa*).—Painful menstruation is exceedingly common, and many women who suffer severely at each period seek no advice nor relief, because they believe a certain amount of pain is a natural accompaniment of the illness. This is not so. Any actual pain is a departure from the proper state of affairs, and ought not to be endured, if it can be got rid of.

The **causes** of the pain are numerous, just as the cause of every other menstrual trouble may depend on a variety of circumstances. In one set of cases the cause is a mechanical one, and consists in some obstacle to the easy flow of the discharge, undue expulsive efforts of the womb being thereby occasioned. Thus the canal leading from the womb may be very small or contracted, the womb may be displaced and bent, so that the canal is encroached on, or at one point blocked by the bending, clots may form readily, and stop the way or require specially violent efforts to expel them, or the way may be barred by a tumour. All these instances come under this class of cases as mechanical causes of painful menstruation. Another set of classes often occurs in which the pain is of a congestive or inflammatory sort, and in others shreds of membrane and casts of the womb are expelled. In a fourth set the pain is more neuralgic in character, not seeming to depend on any special condition of the womb, while the pain in some cases arises from the ovaries.

The commonest cause of painful menstruation is some mechanical obstruction to the flow of the discharge, due either to narrowing of some part of the canal of the womb, or to some displacement. The occurrence of any clots or shreds of membrane will certainly increase the pain by the difficulty of their passage along the narrowed canal.

The **symptoms** of this variety are very intense pain, sometimes agonizing, leading in some cases to fainting, hysterical attacks, or even delirium. The pain often begins before the discharge, and is relieved when any quantity passes, as it sometimes does, in gushes. It begins deep in the belly, but radiates to the groin, thighs, and back. Headache and vomiting are common, and there is often tenderness over the womb and ovaries. The pain may persist throughout the illness. Moreover, the obstacle to the flow tends to produce a congested condition of the womb.

The cases dependent upon congestion have similar symptoms.

Those accompanied by discharge of shreds of the membrane are recognized by the presence of the membranous fragments, and the pain is most intense just before the passage of the membrane, after which it is relieved. When the pain is more ovarian than belonging to the womb, it usually begins a few days or a week before the discharge appears, and may cease with its appearance. It is felt in the situation of the ovaries, in the groin, and commonly on the left side, and there is tenderness over this position. Vomiting and hysterical attacks are common in it. Probably there are few cases really neuralgic in character, those classed thus being likely due to some obscure condition of the ovaries.

Treatment.—The general treatment of painful menstruation consists in rest in bed during the attack, and the employment of hot applications, hot-water bottles, hot fomentations, &c. Great relief will be experienced, in many cases, by the patient taking a hot bath, lasting for twenty to thirty minutes, before going to bed, on one or two nights before the illness is expected. The pain will be relieved by some preparation of opium or other similar soothing drug. The following pill is good for that purpose :—

Morphia, ...	$\frac{1}{12}$th grain.
Extract of Indian Hemp, ...	$\frac{1}{3}$d ,,
Extract of Hyoscyamus,................	$\frac{1}{2}$,,
Extract of Gentian, ...	1 ,,

Make into one pill.

Two or three of these may be taken at intervals of two or three hours between each pill.

Instead of this a dose of 25 to 30 drops of

laudanum, with 5 drops of tincture of belladonna, may be used.

While such a remedy is often necessary, the danger attending the use of any preparation of opium must be strongly pointed out. The desire for the drug becomes strong, and it is used more frequently in ever-increasing quantities. Many women contract a fatal opium habit from using it at such periods. In such a time of suffering, also, stimulants are sought, and relief is obtained from them. The craving for them grows just like the craving for morphia. Thus too many women have become the slaves to opium or whisky, which was originally taken for the relief of urgent suffering.

Under such circumstances it cannot be too strongly urged that everyone suffering in this way should not attempt to treat herself, but should seek competent advice. It is probable that a skilled medical man would discover some unusual condition, which was the cause of the pain, and which he might be able to rectify without the use of drugs, that might in the end prove more disastrous than the original ailment. Thus a displaced womb could be restored to its proper position, and perhaps the painful menstruation could be cured, a contracted passage could be widened, and other unhealthy conditions might be got rid of.

During the interval between two illnesses much relief may be obtained by attention to general conditions of health. Good plain food should be the rule; a daily movement of the bowels ought to be obtained by mild opening medicine, if necessary—for example, a wine-glassful of Hunyadi Janos mineral water each morning on an empty stomach. Opening pills should be avoided. The patient should be warmly clad, with flannel next the skin, and it is necessary to avoid all undue tightness of dress. Fresh air, moderate exercise, avoidance of fatigue, are all of the utmost consequence. Any gouty, rheumatic, or weakly condition of health, such as anæmia (p. 234), needs to be treated. If the pain is felt over the ovaries, 20 grains bromide of potassium, dissolved in water, may be tried every three or four hours.

AFFECTIONS OF THE BLADDER, &c., IN WOMEN.

Painful, difficult, or frequent passing of water very often occurs in women as a consequence of some affection of the womb or genital passage. Inflammation of the passage (p. 498) is apt to spread up to the canal leading to the bladder, and cause frequent desire to pass water, an act which is likely, under these circumstances, to be attended by a hot smarting or burning pain. The same condition may cause spasm at the neck of the bladder, and lead to inability to pass the urine. Specially likely is it that an irritating discharge will set up such a condition and lead to much pain and discomfort, a result that constant care and cleanliness would do much to avoid. A displaced womb, by pressure on the bladder, will readily set up an irritable condition, manifested by pain and a frequent desire to pass water, or will block more or less the passage from the bladder and occasion difficulty of micturition, as the act of passing water is called. Tumours connected with the generative organs may have similar effects. Besides the prominent symptoms of frequent or painful or difficult micturition, there is often produced considerable difficulty in walking, and in turn the walking aggravates the other symptoms. Painful and difficult or frequent micturition may also be quite independent of any disorder of womb or genital passage, and may be occasioned by some unnatural state of the urine, undue acidity, or otherwise altered characters, the result of disease of the kidney or bladder or some constitutional state.

Treatment.—Rest and the use of hot applications give very speedy relief. Heat may be applied in the form of hot-water injections, hot cloths, or hot bottles close up to the parts, or the patient may sit down in a hot bath. Medicated pessaries are also of great value. These are made of cacao butter, in the shape of miniature sugar loaves, some soothing drug being mixed with the cacao butter. The best are those made with extract of belladonna. Each pessary should contain 3 to 5 grains of this extract. The pessary is pushed well into the genital passage, a diaper is then put on, and the patient should rest for some time. This may be employed after the hot-water injection, bath, or fomentation. But the patient must bear in mind, that, though such treatment relieves for the time, it is necessary, if the cure is to be permanent, for any cause of the disturbance, that may be present, to be found and removed.

DISEASES OF PREGNANCY.

Derangements of the Stomach and Digestion are exceedingly common in pregnancy, are in fact almost constant, and are to be regarded as quite natural, if within certain

limits. They depend mainly upon the sympathetic nervous relationship existing between the womb and digestive system; to some extent they are due to the pressure of the enlarging womb, and in some cases may be very marked because of displacement caused by the increased weight of the organ. They may occur throughout the whole course of the pregnancy, but they are often worse in the early months, beginning within a few weeks of conception, and being markedly relieved about the period of quickening, when the womb rises up into the belly. Perhaps the relief at this time is due to the greater room for growth thus afforded, and the consequently lessened pressure. Some women, however, scarcely suffer at all from such disturbances, while in others the distress is excessive. It also, sometimes, happens that a woman who has been much disturbed for two or three pregnancies passes through another almost without them, and the reverse also often happens.

Vomiting is one of the commonest of these disorders, and because of this is counted as one of the earliest and most usual signs of pregnancy (see p. 487). It is only when excessive that it should receive treatment, and it often happens that nothing gives relief. The patient should begin by maintaining the regularity of the bowels, which is best done by a wine-glassful of Hunyadi Janos mineral water, taken each morning before rising. This affords much relief if regularly taken. The effervescing citrate of magnesia is also useful. Then careful attention should be paid to the diet, as the vomiting may be largely controlled by finding the food that agrees best. Marked relief is frequently obtained by taking a cup of warm tea before rising, or by breakfasting in bed, and not rising for some little time afterwards. If such means fail, let the patient try the effect of taking small quantities of food often, and among the kinds of food milk, and milk with soda, are to be preferred, or milk and lime-water. Used in this way barley-water is highly spoken of. Frequent sips of iced milk may be found to allay the irritability. Stimulants may seem desirable, such as brandy in soda-water, or brandy or whisky in milk. The only medicine to be recommended as a soothing agent is bismuth, which may be taken several times a-day in 10-grain doses in water, or 1-grain doses of oxalate of cerium may be tried. A pessary of belladonna (see PESSARIES) has now and again succeeded when other means failed.

In some cases, happily very rare, the vomiting defies treatment, and is so persistent, with even the smallest quantities of food, that the patient becomes much exhausted, and brought into a condition of great danger. It is under such circumstances that a medical man would consider whether he were justified in inducing premature labour. This is a question for a skilled physician carefully to consider; it is here only mentioned as a last resort when the life of the mother seems threatened.

Acidity, Heartburn, and Painful Digestion are other forms of disturbance, and sometimes are the only forms, vomiting being entirely or nearly entirely absent. Bismuth in 10-grain doses, or half a tea-spoonful of the ordinary bicarbonate of soda (baking soda), or bicarbonate of potash, dissolved in water, is useful for these disorders, though the relief is only temporary. To the soda, dissolved in water, a tea-spoonful of sal-volatile (aromatic spirits of ammonia) may with advantage be added.

Constipation is best met by the use of the Hunyadi Janos mineral water, as recommended for vomiting.

Looseness of Bowels may occur every now and again. It should be met if possible by change of diet, the use of lime-water and milk, &c. If these means fail, 5 to 10 drops of laudanum in water may be employed, but this is to be had recourse to sparingly and with care.

Perverted Appetite or **Loss of Appetite** is another of the troubles of pregnancy. The craving for improper articles must be resisted, but a feeble appetite must be coaxed, and careful dieting will usually be sufficient to meet it.

Disturbances of Breathing are happily not so common as those of digestion. The mere bulk of the enlarging womb will occasion some difficulty of breathing. To meet this the patient must dress in the most suitable way. Difficulty of breathing is occasionally due to asthmatical attacks or bronchitis, and where such exists it would be well to obtain competent advice without delay. (Refer to pages 270 and 273, where these affections are discussed.) Cough ought not to be neglected. In some cases its violence threatens to provoke a miscarriage.

Disturbances due to pressure are frequent in the course of the child-carrying period, and specially, as might be expected, towards the end of the period. The **bladder** is peculiarly apt to be pressed upon, and frequent passing of water, pain in the act, or difficulty in emptying the bladder may be experienced. Dribbling of urine may arise from pressure on the neck of

the bladder interfering with its proper emptying, and may be thus the result not of inability to retain the water, but from the bladder being constantly overfull. A bandage carefully adjusted while the patient is lying down will often relieve such symptoms by the support it affords to the womb. Occasionally the use of a belladonna pessary (see PESSARIES) or the application of hot-water pads relieves irritability. Sometimes the patient will overcome difficulty in making water by changing the position usual in the act of passing water, but sometimes it is necessary to pass the catheter to empty the bladder.

Dropsy, Varicose Veins, and **Piles** are frequent in pregnancy as the result of pressure by the enlarging womb on veins preventing the due return of blood. The feet and legs suffer from the dropsical swelling, and the veins of the inner side of the knee and also of the ankle become swollen and prominent, forming varicose veins (see p. 247). Sometimes the ankle becomes much discoloured, in consequence, as if it had been severely bruised. For these conditions there is no cure. They will in nearly every instance disappear after delivery. Some relief may, however, be given by supporting the womb with a bandage put on as the woman lies on her back, and by supporting the veins of the leg with properly-adjusted bandages. All garters should be discarded and nothing worn tight round the knee. Elastic stockings, if properly fitted, are very useful. The bowels should be regulated with the Hunyadi mineral water already recommended. Piles often also disappear after delivery. Certainly no operation for their cure should be undertaken during pregnancy. If they are painful, bathing with very hot water gives great relief, and the gall and opium ointment or the tincture of witch-hazel (the American Pond's Extract) may be applied to relieve pain and arrest bleeding. In this case regularity of the bowels is everything.

Dropsy during pregnancy may, however, be the result of an affection of the kidney, termed **albuminuria** (see p. 302). In such a case it affects not the lower limbs merely but the whole body, and is a much graver condition than the dropsy due to mechanical pressure. The legs are greatly swollen, and the face puffy. There are also other symptoms, such as headache, dimness of sight, and in severe cases convulsions. The symptoms may, however, not be so serious, and after delivery they may entirely disappear. But a patient who, during pregnancy, suffers from swelling not of the legs only but also of other parts of the body should seek competent advice at once. It is not a condition for which treatment can be definitely laid down here.

Another form of dropsy, called **dropsy of the amnion,** may be mentioned here. It has been pointed out (p. 485) that the growing child is inclosed within a double sac between the walls of which fluid is contained, the waters. In ordinary circumstances the quantity of fluid would not be more than 2 or 3 pints, but in some cases the quantity is enormously increased. It produces in such cases most excessive enlargement, and is a source of extreme discomfort to the mother, interfering with movement, affecting breathing, &c. It is usually after the middle of pregnancy that the excess shows itself, not much before the fifth month, and it is commoner in twin pregnancies. When the distension is very great the breathing may be so difficult that some treatment is needed. Nature has often afforded relief by the membranes spontaneously rupturing, inducing premature labour. If it were proved necessary, a physician would imitate this procedure. It is not a condition, however, threatening the mother, but it does seriously that of the child.

Nervous Affections are not uncommon during the child-bearing period. It is quite common for pregnant women to manifest marked alterations in character, an unusual irritability of temper, a tendency to fretfulness, capriciousness, or melancholy, hysterical tendencies also, the woman being easily moved to tears or laughter. Indications of nervous disturbances are also found in perversions of taste, smell, &c. More than this, however, there may be marked signs of mental disturbance, and actual insanity. Convulsions sometimes occur, which may be associated, as mentioned above, with the altered condition of the urine, called albuminuria. As these affections are more common during and after delivery they will be considered later (see p. 517).

Miscarriage and Abortion are both used to indicate that the offspring has been expelled from the womb before the full period of pregnancy is completed. Abortion is the word which ought to be employed when the expulsion takes place before the eighth month, before the period, that is, when the child has the chance of surviving, and miscarriage is employed after that period, when it is still possible for the child to live. The phrase **premature labour** is still

better to indicate the latter state of affairs. There is no doubt that the product of conception is very often expelled from the womb within a few weeks of conception taking place without the woman being aware of the fact. She thinks her monthly illness has only been delayed. The commonest period for abortion is between the eighth and twelfth week of pregnancy.

The **causes** are very numerous. Accidents, blows, falls, &c., indiscreet exertion in dancing, for example, irritation arising in the bowel from the presence of worms, or the occurrence of diarrhœa, irritation in the genital passage or womb itself, all these may cause it. It may be due also to disease, diseases attended by fever, or any serious disease whatever; it may be the result of a diseased ovum, of tumours connected with the womb, or displacements of the womb. Strong emotion may excite it, and various drugs act on the womb in a way to excite it to expel its contents.

It must be noted also that the womb may readily acquire a habit of expelling its contents at a particular period. If abortion has occurred once or twice about the same time, there will be special danger of the same occurrence about the same time in future pregnancies.

Symptoms.—The chief symptom, to begin with, is pain—pain in the back and in front also. If the abortion is very early, the pain may be trifling, but the more advanced the pregnancy, the larger will be the mass to be expelled, and the greater the pain. Previous to the pain, a cold uneasy feeling is experienced at the lower part of the belly in front, along with a sense of weight, and the morning sickness and fulness of the breasts may have disappeared. The pain lasts for a time, passes off, and after a longer or shorter interval, returns. A discharge of blood also appears, which varies in amount in different cases. On the quantity of blood which has been discharged one bases an opinion as to whether or not the threatened abortion can be prevented. If the discharge has been considerable, and repeated, and if the pains keep returning, there is little hope of averting the expulsion of the contents of the uterus. If the pregnancy is advanced to the formation of membranes and fluid, and if the membranes have ruptured and the waters escaped, that is conclusive evidence that the process cannot now be checked.

If any reliable information could be obtained as to whether the offspring were alive or not, that would be a great aid in solving the chief difficulty of the situation. If its death were certain, the expulsive efforts of the womb would be encouraged; if its life were certain, they would be restrained if possible. The feeling of coldness and weight referred to are held as indicating the death of the offspring. Should the pregnancy be advanced beyond the period of quickening the cessation of all movements on the part of the child would lead to the conclusion that it was dead. This must not be too readily accepted as proof. It has often happened that the movements have ceased for days, till the mother became convinced of the child's death, and yet it has been born alive. In some cases the expulsion of a dead ovum has not taken place for a long time after the death had occurred.

When the abortion or miscarriage actually occurs, the important thing to secure is that everything is expelled from the womb. It is always desirable, in order to make certain that this has occurred, for all clots, &c., to be kept till seen by the medical attendant. In abortion in the earliest months everything is usually expelled together in the form of a fleshy mass, but from the third month there is greater liability of something being retained, which will lead to subsequent trouble. After the sixth month the miscarriage becomes similar to labour at full time, but more easily accomplished.

Treatment.—The first and most essential part of treatment is rest, complete rest in bed, the patient lying flat, with head low. If the abortion or miscarriage is only threatened this is the first and chief means to ward it off. Unstimulating light diet is to be given, and always cold. If pain is the chief symptom, an opiate is very valuable, say 30 drops of laudanum, which would be best given mixed with a teacupful of thickish starch as an injection into the bowel. If a discharge of blood is the chief symptom acid drinks and a lead and opium pill is advised. Repeated doses of opiates should, however, never be given without medical orders. If the abortion is arrested, rest must be continued for a prolonged period, and great care exercised. If such treatment does not arrest the expulsive action, if the pains are returning at regular intervals in strength, and the discharge of blood is considerable, and certainly if the waters have come away, other treatment, designed to aid the process, is needed. For this purpose from a half to a tea-spoonful of liquid extract of ergot is given every third hour till everything is expelled.

A woman who has miscarried or aborted

must be treated in every way as one who has been delivered at the full time, and must be allowed as long a period of rest in bed afterwards. Further, such an one must remember that she runs special risks of repeating the same performance at a similar period of a later pregnancy, and must, therefore, take special precautions about such a time, avoiding undue exertion and fatigue, and, it is specially to be noticed, *avoiding all sexual excitement.*

Flooding is the ordinary term applied to profuse loss of blood from the womb. It may occur either before the period of confinement or afterwards. Of course loss of blood occurs in abortion, but it is attended usually by the pains, which indicate what is going on. Alarming losses of blood occur within the last three months of pregnancy, due to the placenta, or after-birth, occupying a peculiar position in the womb. This is called properly **placenta previa.** The after-birth is situated partially or wholly over the passage, through which during delivery the child must pass, and, therefore, it is separated either wholly or partially some time before the birth can occur. By this separation blood-vessels are opened, and the womb not being able, owing to its contents, to contract and close the bleeding vessels, a great loss of blood occurs very speedily. The actual determination of this condition can only be made by a medical man after a careful examination; but a profuse loss of blood occurring within the last three months of pregnancy, without any apparent cause, should cause a woman to seek immediate skilled advice. Sometimes there is no sign of this condition till the full time, after labour has set in, and then the loss of blood may be immediately so great that the life of the mother is threatened before any assistance can be obtained.

Treatment.—Medical aid cannot be dispensed with. All that others can do is to put the patient to rest on a hard bed, with low head, and to give low diet, cold, all stimulants being avoided. If the loss of blood is great and danger threatening before aid can arrive, attempts may be made to stop the flow of blood by plugging the passage. This is to be done by pushing up strips of lint one after another, or pieces of a silk handkerchief, till the whole passage is thoroughly packed. Tea-spoonful doses of the liquid extract of ergot may also be given in cold water every third hour.

Flooding after delivery will readily occur if the after-birth has not been expelled. It also occurs when everything has gone on satisfactorily, the after-birth has been removed, and all has seemed well, owing to the womb relaxing, because of want of vigour, and permitting the torn vessels again to open and pour out blood. The **symptoms** are not only the visible flow of blood, but the patient complains of faintness or dim sight; she is white and cold, with clammy skin. In the former case the after-birth must be got rid of. A medical man would probably pass up his hand into the womb and remove it. In the absence of such assistance let a large dose of the liquid extract of ergot be given, one to two tea-spoonfuls. Let someone place the *cold* hand over the lower part of the woman's belly and rub, with the design of exciting the womb to contract. Cold water may be dashed over the belly and cold water injected into the genital passage by an enema syringe. Similar treatment is to be adopted if the bleeding occurs after the after-birth has been removed.

Molar Pregnancy or Blighted Ovum.—Sometimes the product of conception dies without abortion speedily occurring. Owing to some part of it remaining connected with the womb, growth goes on, the membranes undergoing thickening and degeneration. This may continue till at length a fleshy mass is discharged called the **flesh-mole.** In other cases one of the membranes undergoes a peculiar development, so that a mass is produced resembling a bunch of currants, when seen floating in water coloured with some of the discharged blood, like a mass of "white currants in red currant juice." This is the **vesicular mole.**

Symptoms.—In each case the woman usually suspects something is wrong. The usual symptoms of pregnancy are experienced for a time, but the enlargement of the belly is much more rapid than usual. In the case of the fleshy mole, the growth is so rapid that at the end of the third month the enlargement is as great as is customary at the end of the fifth. In the case of the vesicular mole the normal symptoms go on till about the third month, and then enlargement becomes very rapid, and is more towards the side than upwards. The other usual symptoms are indistinct, the patient feels differently from what she did in other pregnancies. Watery discharges, mixed with blood, may occur, and the feelings of movement of the child are not experienced.

The mole is usually expelled after six months. It has sometimes occurred in twin pregnancy

that one of the ova has undergone such degeneration, and the other has followed a normal development, so that at the sixth month a living child has occupied the womb along with a vesicular mole. In such a case the danger is that the expulsive efforts of the womb do not end with ridding it of the mole, but go on to the expulsion of the fœtus, at a time when it cannot survive. Some cases are recorded, however, in which the mole was expelled, and a healthy living child was born at the full time.

Treatment of such cases rests, of course, with a physician. In any case where such cannot be obtained soon, and there is considerable watery and bloody discharge, especially if some of the currant-like material has been expelled and shows clearly the nature of the case, error can hardly be committed by giving full doses (teaspoonful) of the liquid extract of ergot of rye, every two or three hours, as long as seems necessary.

DISEASES AFTER CHILD-BIRTH.

Flooding (*Hæmorrhage*) has already been sufficiently discussed in the previous paragraphs (p. 515).

Milk Fever.—On the third day after delivery the rush of milk to the breasts becomes usually very marked, and is frequently attended by considerable disturbance, feverishness, quick pulse, and headache. The breasts are very full and may be hard, and markedly knotted and painful. This is the condition called **milk fever,** and also called popularly a **weed.** If care has been exercised all through the period of delivery and after it, and everything has been scrupulously clean, if also the directions given on p. 496 have been followed, and in particular if the child has been regularly put to the breast every third hour (see p. 438), the chances of such a condition arising are extremely small.

Treatment.—Give a strong dose of opening medicine, a double-strong seidlitz-powder being preferred, or a full ounce of castor-oil. Put the child regularly to the breast every 2½ hours. If, owing to the swelling of the breast, the nipple is below the level of the breast, let it be pulled out by means of a breast-exhauster; and if the child cannot empty the breast, let the breast-exhauster be used as well. It is necessary to keep down the swelling in every way possible. Much relief will be given by laying over the breasts a soft handkerchief, soaked with ice-cold water. This may be renewed every quarter of an hour or so, if it is giving relief, but care must be taken not to overdo this, and not to permit the mother's clothing to become wet in the process. Warm applications, in some cases, are advised, but are to be used at first with caution. The cooling application should first be tried. If the breasts are knotted, gentle light rubbing with oil aids their relief. Meantime liquids must be given to the mother sparingly, and more solid food given. She may suck a small piece of ice to relieve thirst.

If, within a very few hours, these measures have not given relief, 10 grains of Dover's powder may be given in water, *but not until the bowels have been freely opened.* A second may be given in four hours, and, if it seems useful, a third six hours after the second, but no more without advice. The bowels will probably require to be opened again by medicine, as the powders have a binding effect.

Affections of the Breast after child-birth are very commonly due to the constant worry and irritation of cracks and fissures of the nipples. These are to be avoided by regular nursing, by carefully bathing the nipples after each nursing with cold water and drying them, and by the use of some agent which will toughen the skin, of which the best is glycerine of tannin, or glycerine of borax. It is not a matter of wonder if a mother suffers from tender nipples who permits her child to be continually at the breast, so that one nipple or another is constantly in the child's mouth. Some mothers suffer from such an excessive flow of milk that the dress is continually wet and the breast continually in a milk-bath. This will naturally make the skin tender and readily crack. Keeping the breasts as dry as possible, and limiting the flow of milk, if possible, by dieting, are the remedies. If the nipples are hacked and painful, the use of a nipple shield (see Plate VIII.) during nursing gives much relief, the other treatment already indicated being employed.

It is needful to bathe off, with cold water, the tannin and glycerine or other application before putting the child to the breast.

Abscess or "Gathered Breast" often results from neglected cracks and painful nipples. The breast becomes full and swollen and painful, especially over one part, which also becomes hard. The breast should be treated as recommended under milk-fever, first with the iced-water, and then, if it fails, with hot water

applications. A brisk dose of opening medicine (seidlitz-powder) should be given. If matter forms, it must be "let out" by the abscess being opened, and should on no account be allowed to burst.

Whenever the breasts are large and swollen, great relief is given by a bandage passing under the affected breast and over the opposite shoulder, so as to support it.

It is also necessary to keep down the swelling of the breasts as much as possible by regular removals of the milk. If this is not properly done by the child, a breast-exhauster, or breast-pump, must be secured at once, and the milk must be frequently drawn off by its means. The exhauster and its mode of application are shown in Plate VIII. It is advisable to apply the exhauster every two hours or so, to remove by its means small quantities of milk frequently rather than to attempt to remove a large quantity at one time. If this is done and the other measures advised are adopted, threatened inflammation of the breasts will often be speedily subdued.

Convulsions occurring during pregnancy or labour, or after child-birth, are of very serious meaning. They are commonly due to the condition known as albuminuria (see pp. 295 and 513), although they may occur without such a condition, caused, as some believe, by a too watery condition of the blood inducing a state of bloodlessness (ANÆMIA, p. 234) of the nerve centres.

Symptoms.—Convulsions may occur without any warning, but usually warning of the coming attack is given by the occurrence of headache, usually of the front of the head, of a very intense kind, and likely to be continuous when the fit is near at hand. Another warning sign is derangement of vision, dimness or cloudiness of sight, or some other disturbance of clearness of sight. In a few cases severe pain is felt over the pit of the stomach. One sign which ought not to be disregarded is puffiness of the face, and swelling of the ankles, feet, and external genital organs. Such a condition ought to lead to immediate medical advice. The fit itself is of a marked kind. The eyes are fixed, within a few seconds the face and eyelids are spasmodically twitched, the eyeballs roll, and the face is pulled down first to one shoulder and then to the other, the mouth being also twisted, and the upturned eyes show only the white part of the ball. The convulsive movement then passes quickly over the rest of the body, and for a little the whole body is stiff, head being bent back, limbs stretched out, and hands clenched. After a brief period irregular spasmodic movements occur of great violence. The face is violently twitched, the arms jerked, the tongue is often caught between the teeth and severely bitten, and froth mixed with blood from the tongue escapes from the mouth. Breathing is suspended till the face becomes purple. Motions from the bowels and water from the bladder are often passed. All this time there is complete loss of feeling and consciousness. As the fit passes off the spasms become less, the movements gradually cease, breathing becomes natural, and the face loses the purplish hue, and consciousness may be soon restored, or the patient may lie in a heavy torpor for some hours. When consciousness is restored the patient complains probably of headache and a dull stupid feeling. One attack may succeed another, consciousness not returning in the intervals, or there may be but one attack altogether.

The more severe and prolonged the attack, and the more frequent its recurrence, the graver is the case, though the author has seen one attack follow another for a couple of hours, and recovery take place. One in every three or four cases proves fatal.

If the convulsions occur before labour has set in they are extremely likely to provoke labour, and thus the life of the child is threatened. When labour is brought on it is often accomplished with great rapidity. The birth of the child has, however, a tendency to lessen the severity of the attack.

Treatment.—Very little can be done by an unskilled person. A medical man would probably administer chloroform, and if labour had begun would, if possible, effect delivery. Harm would not be done if, when medical aid was not obtainable, a draught containing 20 grains of chloral hydrate, dissolved in water and simple syrup, were given immediately after one attack to prevent, if possible, a second. The dose could be repeated in three or four hours.

Insanity may occur during the child-bearing period, during labour, or after delivery. It is most common in those with child for the first time, and in many there is an inherited tendency. In cases occurring during the child-carrying period, or after delivery, the commonest form is melancholia, evidenced by great depression of spirits and delusions, and when the case

is a severe one there is a tendency to suicide. These cases are more apt to occur in weakly, ill-nourished women, or those who have been much reduced by frequent pregnancies, prolonged nursing, or intemperance. Insanity during the progress of labour is frequently in the form of maniacal excitement, occurring during the most painful part of the process. The attack of mania may also occur some time after delivery, within a week or ten days, and occurs suddenly, or after a period of sleeplessness. There is considerable fever, small throbbing pulse, and bright eyes. The patient regards her attendants with suspicion. She talks excitedly, and the talk passes into raving, and she may attempt her own or her child's life. There is great sleeplessness, and the milk and discharge cease. Digestion is very seriously disturbed, the urine is high-coloured and scanty, and the bowels usually costive, though they may be loose. Recovery occurs in nearly three-fourths of the cases, that from mania may be within three or four weeks. Melancholia is less threatening to life but more to reason. It may last from a few weeks to a year or more, but most of the recoveries occur within six months.

Treatment.—Mania occurring during labour is met by chloroform. If it occurs afterwards the bowels should be unloaded by means of a simple injection of warm water and soap, and 20-grain doses of bromide of potassium in water may be given every four hours. But such cases are too serious and demand too much skill and care to be treated by any but qualified persons. The melancholic form needs, above all, careful dieting and quietness, freedom from worry and annoyance, kindly and watchful attendance, which had better be given by strangers than by the patient's own friends. A woman who thus suffers, or has suffered, should not attempt to nurse her child.

Puerperal Fever (*Child-bed Fever*).—This is one of the most appalling diseases that may follow child-birth. In most cases it is fatal within a very short period, ten days or so after delivery. It may be regarded as due to the passage into the blood of some poisonous material, probably of the nature of a living organism, such as has been discussed in Section XIII., which multiplies in the patient's body, and produces by its activity all the symptoms of the disease. The poisonous material may come (1) from the patient herself, or (2) may be introduced from without by, unhappily it is so, the doctor, the midwife, the nurse, or other attendant, or (3) as contagion from some other disease. Thus, to take examples, a patient may have had a miscarriage, the whole of the after-birth, membranes, &c., may not have come away. The retained portions may undergo changes of decomposition in the womb. Suppose now the woman again becomes pregnant. After delivery some of this decomposed material may pass into the blood and occasion the fever. Or a similar thing may occur at an ordinary confinement, fragments of the after-birth may remain behind, undergo putrefaction, and occasion the disease. Thus the woman may infect herself. A medical man may convey the disease by attending a confinement after assisting at a *post-mortem*, or after dressing foul wounds, &c. Similarly it may be occasioned by the use of unclean instruments, sponges, syringes, &c. An example of the third means of communication is afforded by erysipelas and scarlet fever. These diseases attacking a woman recently confined assume extremely violent and fatal characters, due to the peculiar condition in which necessarily the woman happens at that time to be.

Puerperal fever is a contagious disease. The danger of it being carried from one suffering from it to another patient in the process of confinement is enormous. No conscientious medical man will go from a case of puerperal fever to attend another confinement case without previously taking the greatest precautions against carrying the disease with him.

The disease, it will thus be understood, does not assume necessarily the same form in each case. In one apparently the poison is absorbed in a very fine form, and multiplying in the blood produces violent fever, diarrhœa, delirium, &c. In others it is absorbed, as it would seem, by the mouths of the open veins of the womb, in the form of larger particles, which, being carried with the blood current through the body, are arrested in various places, and form small abscesses. In such cases little abscesses may be visible on the skin, on the fingers, &c. In other cases the disease is in the form of an acute inflammation within the belly, as peritonitis (see p. 190), or as inflammation of the womb itself. Inflammation of the lungs and other organs may speedily arise in the course of the disease, due, doubtless, to the conveyance to these organs of some of the poisonous material.

Symptoms.—All of the various forms cannot be described, but we may state in some detail the characters of the fever in general. It begins

usually within three or four days after delivery, perhaps with a shivering fit (rigor), headache, and depression. The fever soon runs up to a considerable height, 103° or more by the thermometer (see p. 10). The pulse is rapid and feeble, the skin dry as well as hot; sometimes there is much sweating, and the sweat has a peculiar odour. The discharge from the genitals may cease; sometimes it does not, and the discharge is foul-smelling. The formation of milk is usually arrested. The bowels are loose, and the motions very offensive. The tongue becomes brown and dry, and little brown masses (*sordes*) form on the lips. Vomiting is frequent, the vomit being offensive. There is usually some amount of pain in the belly, which may become much swollen, adding to the distress. If muttering delirium sets in, and the patient's hands wander about picking at the bed-clothes, the case is as grave as can be. A very hurried feeble pulse, and rapid panting breathing, indicate sinking from exhaustion.

In other cases, at the very beginning of the fever, the patient complains of acute pain in one spot, usually low down in the belly, and the pain is apt rapidly to extend over the whole belly, which becomes much swollen, and is so painful that the mere weight of the clothes is distressing. To obtain some relief the patient lies on her back, with her knees drawn up. In such a case, instead of the bowels being loose, they are usually obstinately costive. Later on severe looseness of bowels sets in.

Treatment is too often utterly in vain. But if everyone were scrupulously careful cases of this disease ought to become exceedingly rare.

Moreover, the variety of the disease is so great that no one method of treatment is suited for each case. While stating this very strongly, we may even in such a very serious disease go on the same principle that pervades this book, and indicate general lines of treatment that may be adopted by any unfortunate enough to have no medical aid within reach. It is best to begin by clearing out the bowels with a large injection of tepid water, three or four pints. Nourishing food and stimulants must be freely given. Milk, eggs, nourishing soups, such as mutton soup, beef-tea, hough soup, &c., should be given in small quantities often, unless very loose bowels prevent much use of soups. Their loosening effect on the bowels may be to some extent checked by thickening them somewhat with corn-flour, &c. Whisky or brandy should be given in small quantities with milk to the extent of three or four ounces (one to two wine-glassfuls) per day, if it seems to agree. Port wine is also useful and champagne. The fever is somewhat held in check by large doses of quinine, 10 to 15 grains every fourth or sixth hour; and to this may be added 10 grains of Dover's powder, if it seems to agree with the patient. If there is pain in the belly, a thick pad of flannel should be lightly wrung out of hot water, sprinkled with turpentine, and laid over the belly. This is kept on and repeated till the whole surface is red. If discharge from the genitals is fœtid, injections must be used with an enema syringe, fitted with a long delivery tube. Water, rendered pink with Condy's fluid, is employed to the extent of two or three pints, or carbolic acid solution of a strength of one ounce of the acid to two pints of water. This injection may be repeated twice daily. Great care must be taken that the injected fluid escapes freely. The patient's room must be freely but carefully ventilated.

STERILITY.

Sterility is want of the power of reproducing offspring, and is to be distinguished from impotence, which means inability for sexual intercourse. Sterility is not necessarily the fault of the wife. It may also be due to defect in the husband. In all cases it is desirable that this should not be overlooked, though here only sterility in the female will be considered.

In the first place, it may be that the sexual act is not duly performed. This is more frequent than might be supposed, for neither husband nor wife cares to consult even the medical attendant when the act of intercourse is attended with difficulty. Such a condition is called **dyspareunia.** Sometimes the genital passage of the female is so narrow, either naturally or as the result of inflammatory contraction, as to cause the difficulty, or the presence of painful spots or excrescences renders the act so painful that it is discontinued. The writer has treated such cases, in which this condition had existed for years without any remedy being sought, because of the idea that relief could not be obtained. It should, therefore, be plainly stated that this idea is in many cases erroneous, and that often a cure is easy of accomplishment, involving no severe or heroic method of treatment. Supposing, however, the sexual act to be duly performed, and supposing no defect to exist in the husband, the intercourse may be barren, from a variety of causes. The cause may lie in the ovaries

(p. 480), where the ova are developed, or in the tubes (fallopian tubes, p. 480), down which the ova should be conducted to the womb, or in the womb itself, or in the genital passage.

In rare cases the ovaries are absent or imperfectly developed, and do not perform their function of producing the female element in the reproductive act. It may be that the ovaries have been mature, but have been destroyed by inflammatory or other disease. In some cases the ovaries are displaced, and the ova are ripened but do not find their way to the fallopian tubes. Inflammation may have blocked the tubes so that the ova cannot pass down to the womb. Again, the fault may exist in the womb, which, in very rare cases, is altogether absent or has never grown to maturity. More commonly displacement or inflammation of the womb is a cause of sterility, the displacement preventing the due meeting of the male and female element in conception, and inflammation rendering the womb unfit for its duty of receiving and retaining an ovum which has undergone the changes of conception. In many cases the discharge from a womb that is the seat of such a disease is destructive to the life of the male element, and conception is thus prevented. In other cases of sterility tumours of the womb are the cause. Sometimes the cause is a very contracted state of the mouth and neck of the womb preventing the passing upwards of the fluid from the male. An inflammatory condition of the genital passage, specially such as is attended by a profuse discharge, produces sterility by the injurious effect of the discharge on the semen from the male.

Treatment in each case depends on the cause of the failure. Displaced and inflammatory conditions of the womb, as well as contracted states of the neck and mouth of the womb, &c., are all open to treatment, and the treatment in many cases is attended by the desired result. But women ought to be warned to trust only the opinion and advice of well-informed and conscientious physicians.

NERVOUS DISEASES OF WOMEN.

Hysteria, Catalepsy, and Trance.

Hysteria (Greek *hustera*, the womb).—This is so remarkable and amazing a disease, having so many varied forms, and producing so many perplexing manifestations, that it is doubtful if any but the briefest notice of it is necessary in a work like this. It is a puzzle and plague to nearly every physician. It is apparently due to a peculiar nervous condition, not necessarily attended by any structural change or disease in the nervous organs. It does occur rarely in men, but is very common in women, most frequently between the ages of fifteen and thirty, and specially between the ages of fifteen and twenty. Very commonly it is associated with some disturbance of the genital organs, often slight in itself, but sufficient in the case of nervous girls to excite the manifestations of the disorder. In those liable to nervous disturbance it may be induced by too luxurious and indolent habits, by unfortunate surroundings, badly directed training, and various other causes. The fact that men are, though rarely, affected with hysteria, is sufficient proof that it is not necessarily related in women to the genital organs. Yet it must never be overlooked that some disorder, perhaps slight, of the organs of generation may be the exciting cause in women. In those liable to it, some such disturbance may occasion an attack, and the continuance of the condition may cause repeated recurrences of the attacks for a prolonged period. It is always, therefore, desirable to make sure that there is no such exciting cause at work, and this can only be done by a skilled physician.

Symptoms.—Hysteria may produce symptoms referred to every organ of the body. Symptoms related to the digestive organs are frequent, such as loss of appetite, obstinate vomiting, costiveness, excessive development of gas in the bowels. Disturbance of the heart, fainting, &c., are common. Spasmodic seizures and fits of various kinds are of common occurrence. It is a spasmodic contracting of the throat, often excited by flatulence, that gives rise to the feeling of a ball in the throat common in hysteria, and which has been called *globus hystericus.* Paralysis of the legs, loss of voice and speech, loss of feeling in various parts of the body, may all be the result of a hysterical condition. On the other hand, excessive tenderness of some parts is frequent. Hysterical neuralgia, pain in a joint, in the breast, in the head, or over the stomach, are common. The determination of the true nature of these disturbances is a matter of great difficulty. The mental condition of hysterical persons is also peculiar. They are nervous and excitable, prone to laugh or cry at trifles, with little control over their emotions, irritable, querulous, and quarrelsome.

Treatment.—The main element in treatment is firm and judicious control. If the person can

be removed from the care of anxious friends and placed entirely under the discipline of strangers, much benefit will result. Hysterical convulsions can usually be cut short by dashing quantities of cold water about the person's face.

Catalepsy is a peculiar nervous condition, in which the patient loses all consciousness. At the same time the muscles of the body become so stiff, that if a limb be placed in any position, no matter how unusual or difficult to maintain in ordinary circumstances, that position will be kept for a considerable length of time. The condition may last from a few minutes to several hours; and it may pass off suddenly or slowly. It is met with usually at the same age as hysteria, but it has occurred at as early an age as 5 years, and also in advanced life. During the attack the face is without expression and pale, and the movements of breathing are slowed, as also is the action of the heart.

The patient retains the position in which she was when seized. The muscles become rigid, and after this stiffness is overcome they become pliant, and can be moulded, as it were, like wax, into any position consistent with the integrity of the parts. This position will be maintained till the muscles become exhausted.

The surface of the body may become so cold that, the pulse and breathing being barely perceptible, the condition may be mistaken for one of actual death.

Recovery is usually gradual. Attacks may occur at regular intervals, or irregularly and at long intervals; and they may last a variable time, from a few minutes to some hours.

Trance is a condition resembling sleep, which usually comes on suddenly, without any apparent cause, and from which the person cannot be roused.

It occurs chiefly in women between the ages of twelve and thirty. It is a rare condition. The subjects of it are usually hysterical, and it occurs in some cases as the result of exhausting disease, or excited by some emotional disturbance. It may last for a variable period, from several hours to many weeks or months. During its occurrence the countenance is pale, and the limbs are relaxed. No attempt at rousing produces return to consciousness, while the attack lasts. In most cases the mental functions are in abeyance; but sometimes the person knows what is going on, though unable to make the slightest movement. The action of the heart is diminished, and the breathing reduced. The bowels are moved, and water passed, as in health. When the trance lasts for a lengthened period, the patient partially rouses at intervals, takes food in a mechanical way, and then relapses into stupor. Recovery may take place slowly or suddenly. Most cases recover.

During the attack the nourishment of the person must be maintained by nourishing injections.

Ecstasy is a similar condition, in which, however, while the person is unconscious of impressions from without, the mind is possessed with some fixed idea, often of a religious character. The pulse and breathing are much reduced, the limbs remain in a particular attitude, and the countenance is pale, the eyes wearing a look of absorbed rapture.

PART II.

HYGIENE, OR A CONSIDERATION OF THE EXTERNAL CIRCUMSTANCES WHICH AFFECT THE HEALTH OF INDIVIDUALS AND COMMUNITIES.

INTRODUCTION.

The word *hygiene* is originally French, and means the science of health. It is derived from the Greek *hugieinos*, meaning "good for the health." It implies the study of everything outside of a person's own body which has an influence on his health. In the introduction to Part I., health has been viewed as the result of the harmonious co-operation of all the organs of the body in a sound condition. These we might call the internal conditions of health. It is clear, however, that if we limit our view to these internal conditions, we overlook a large number of circumstances which have an immediate and constant influence on the state of the body. Disease is more frequently due to a cause acting from without than to some condition originating from within. If, therefore, we are to have a fair all-round view of the conditions of health, we must give a careful study to the surroundings of a person, and observe how he is affected by them, we must study the conditions external to him, which directly and more or less constantly have a relation to his life. It is with these surroundings that the science of hygiene has to deal.

Now, the most striking of the outside agencies which constantly influence the bodily condition are the food a person eats, the liquids he drinks, and the air he breathes. These have already been considered (in Part I.), so far as was needful for our understanding of their general use within the body. But all details regarding, for example, the nature and composition of foods, the sources of foods, and the relation between their composition and their value to the human body, the varieties of liquids in common use, their varying properties and consequent effects upon the body, the various atmospheric conditions included under the term climate, and the influence they have upon human life, have been omitted in Part I. as foreign to the immediate purpose in hand. Yet they are all of the utmost importance. Again, the activity of the skin depends largely on the degree of heat and moisture of the external atmosphere, and the activity of the skin is remarkably related to the action of the kidneys, so that a change in the external atmosphere will profoundly affect the whole body. We can modify or alter the influence exerted by the atmosphere by the nature and amount of clothing worn. So it becomes of extreme interest to ask how and why clothing influences health. Further, while a person cannot voluntarily or directly affect the action of his heart, the activity of his circulation, or the rate at which his liver and kidneys remove waste from the body, he may indirectly but powerfully influence all these by the kind of work or exercise he engages in. Therefore the effects of exercise on health, whether in the form of work or play, become an important part of the study of hygiene.

In the next place we must remember how materially man alters the natural conditions of life, how very different, for example, may be the atmosphere he breathes from that he was, so to speak, designed to breathe, because of the nature of the dwelling in which he lives, because of the alteration of the composition of the air from the addition to it of foreign particles, produced by various kinds of industry, such as chemical works, or by metal grinding, such as brass grinding, &c., or because of additions to the air of organic impurities, such as are cast off from his own body in the course of its natural activity. So that in face of the ever-increasing developments of modern industry, the continual new departures which modern industrial progress renders necessary, and the new and unusual conditions of life they create, it becomes more and more a daily and urgent necessity that the principles of health should be studied, and their bearings on new conditions realized.

Every one who endeavours to arouse the public interest in such questions, and to direct the public attention to them, is met by the question, "How comes it that our forefathers

lived healthy and useful lives in spite of their ignorance of such principles, and how should we not be as healthy as they without such knowledge?" The answer is, that the tendency for men to mass themselves together in large communities has never been so marked as in quite recent times; and it is the formation of large communities and the growth of crowded cities that create conditions hostile to health, and render necessary the deliberate facing of the question how, in spite of such hostile conditions, health may yet be preserved. Men must be considered in the relationship they bear to one another, simply in virtue of their proximity to one another, and in view of the influence they exert on one another because of that proximity.

Each individual gives off organic material from his lungs, from his skin, from his kidneys, and from his bowels, which it is highly undesirable that his neighbour should get the benefit of, and exceedingly undesirable if he happens to be suffering from a disease, which may be communicated by such means, as many diseases may be (see Part I., section XIII.). In the ordinary course such organic materials would undergo destruction by natural agencies. In contact with the air they suffer oxidation or combustion, by which they are reduced to simple and harmless substances. Material cast off from the body and thrown upon the surface of the earth rapidly undergoes such combustion; discharged into the running stream, it is equally destroyed by the agency of the oxygen contained in the air dissolved by the water. Now, while "the self-cleansing properties of nature" are sufficient to effect their purpose speedily, where men live in scattered groups over a country, it is very different when men are so crowded together that the amount of air-space and earth-space for each becomes reduced to a minimum. To take an actual illustration, "there are ten rural counties in Scotland inhabited at the rate of only 41 persons per square mile, on the average of the ten years 1866–1875, while in Glasgow we endeavour to live in the proportion of 53,224 persons per square mile." Supposing the persons to be equally distributed over the square mile, then "in the ten rural counties each man, woman, and child enjoys an ample area of 16 acres, and is 296 yards from each of his or her neighbours; while in Glasgow each citizen is 'cribbed, cabined, and confined' within less than $\frac{1}{80}$th of an acre, and is only 8 yards from his nearest neighbours." In the former condition of affairs the amount of air-space and earth-space is sufficient to ensure the constant maintenance of healthy surroundings and the speedy destruction, by natural means, of waste organic products. In the latter case the amount of waste is so enormous that nature has no room to deal with it, and special means need to be devised for the removal from the community of the waste, whose accumulation means serious injury to health. One is, therefore, not surprised to learn that "in the rural counties only 17 per 1000 of these happy people die annually, while in Glasgow fully 30 perished in each of the years from 1866 to 1875. Shall we say that in Glasgow we choke and hustle each other out of existence?" (Dr. Russell). In proportion as men crowd together, in a similar proportion does disease multiply and the death-rate increase. So we get hold of "the idea, that vast as are the resources of nature, they are not without limits; and that as we add house to house, and man to man, in our cities, we had better have a care how we do it." Thus hygiene does not only study health in relation to the individual but in its bearings on communities, and we have the departments of private and public health established. Inasmuch, then, as each individual in a community may, by his mode of life, by its effects on his surroundings, seriously affect the welfare of his neighbours, and inasmuch as his neighbours may have no power themselves to put an end to his injurious influence, it becomes necessary to have some state regulation of the conduct of individuals in relation to a community, and there thus arises what is termed "State Medicine."

Hygiene, then, embraces within its scope not only the study of the principles of health in regard to the individual, the food he eats, the water he drinks, the air he breathes, the clothing he wears, the exercise he engages in, the dwelling in which he lives, the occupation at which he is employed, and the means by which the cast-off waste products of his body are removed from his immediate surrounding, but also, in regard to communities, the steps which are to be taken to prevent the accumulation of such waste products and the consequent spread of disease among the community, and such like questions.

In this portion of the book it will be our business to study food, drink, air, exercise, clothing, removal of waste, ventilation, drainage, &c., in their bearings on health, in an order such as has been indicated.

Section I.—FOODS.

FOOD AND ENERGY.

The Meaning of "Energy."—The human body has already been compared to a steam-engine in working order. If the engine is to be kept working and in good condition two things are needful—(1), the engineer must repair regularly any tear and wear, the result of the working of the machine, and (2), a regular supply of fuel must be kept up to maintain the steam. The full meaning of the first of these conditions is plain enough; it will help us materially in arriving at a proper understanding of the nature and purpose of food if we consider more fully what the second implies.

The steam-engine, as it stands completed in the engineer's shop, may be a perfect instrument, and yet it will stand motionless and idle, till "the crack o' doom," unless something more be supplied to it. It possesses all the working parts, properly connected together, but it has no motive power. It lacks *the power of doing work*, that is it possesses no energy, for "energy" is defined as the power of doing work. How does the steam-engine obtain this power? It obtains it from steam at high pressure. Steam at high pressure possesses energy, energy stored up, so long as the steam is imprisoned in the boiler; but as soon as the steam is allowed to expand into the cylinder against the piston-rod, its energy is liberated, and appears in the form of mechanical movement, in the motion of the piston and the wheels to which it is connected. The energy, or power of doing work, stored up in steam at high pressure becomes transformed into energy liberated, work actually done, in the moving steam-engine as it lifts or transports the load attached to it. Thus we may have energy stored up, or as it is called **potential energy**, the power of doing work not in operation, and we may have energy liberated, **actual energy**, the power of doing work in actual operation. There are many illustrations of this difference between potential or stored energy and actual energy. A water-dam is a store of energy. The dammed-up water has the power of doing work, but so long as it is confined behind its barriers it remains only potential energy. If the gates are raised and the water allowed to flow away, its energy is liberated, and in its course to the sea may turn many mill-wheels, so that the potential energy of the dammed-up water becomes transformed into the actual energy of the mill-stones as they grind the flour. A wound-up clock-spring is another illustration of potential energy. While the spring is held by its catch the energy is stored, but as soon as the spring is permitted slowly to uncoil, its energy is liberated, becomes actual, and appears in the movement of the clock-work. Thus steam at high pressure, a head of water, a coiled spring are all illustrations of energy in the potential condition, capable of becoming changed into actual energy, as soon as the steam is permitted to expand, the water to seek the low level, and the spring to uncoil. The winds are illustrations of actual energy, energy being liberated, actual energy which is utilized by the sails of a ship or the arms of a windmill.

The Sources of Energy.—Now the question arises, where did the energy in each case come from? how does steam or a head of water or a coiled spring come to possess the power of doing work? Take the head of water to begin with. It is plain that its power of doing work is due to its position above the sea-level. As soon as it reaches the sea-level its power of doing work is gone. It is the mass of water in its course downwards to the sea that can do work. It is also plain that the higher the dam is above the sea-level, and the larger the quantity of water collected in it, the more work will be got out of it, the larger and the more numerous may be the mill-wheels which it will turn in its downward course. In short, if the height of the water above the sea-level be known, and the quantity of water in the dam, one could obtain an exact idea of the stored-up energy it represented, and of the amount of work that could be got out of the water in its descent. Suppose two dams, containing each the same quantity of water, but one only half the height above sea-level of the other, the water flowing from the high one would be able to do twice the amount of work done by the water from the low one. In short, the energy of falling water is the same as that of a falling weight, which depends on the amount of the weight and the distance through which it has to fall. The stored-up energy of a head of water may, then, be called potential energy *of position*, and the question, how did the water come to possess energy? will be answered if we can tell how the water came to be so high above the sea-level. The answer is easy. The water is the collected rain which has fallen. And what is the rain? Rain is originally vapour raised from the sea, &c., by the heat of the sun. The warm vapour passing through the atmosphere comes into contact with colder portions, clouds are formed, and finally the vapour is condensed by the cold and falls as rain. Collected in the uplands it

forms a head of water. It is the heat of the sun, then, that raised the water from the sea-level to the height, just as truly as a man may raise a weight from the ground and place it in a high position; and the energy of the head of water is really stored-up energy, which at a previous time had been liberated from the sun. The actual energy of the sun, as it does work in raising water from the ocean as vapour, becomes transformed into the potential energy of the mill-dam, and the potential energy of the mill-dam becomes re-transformed into the actual energy of the falling water as it turns the mill-wheel. When the water reaches the sea—and part of it before that—it may become again raised by the sun's heat in the form of vapour to fall as rain among the hills, and the circle of transformation may go on again. The power of doing work possessed by a head of water is thus derived from the sun. What of the energy of winds? Winds are due to differences of temperature in the air, the differences producing currents in the atmosphere. Take the case of the trade-winds. The sun's rays, beating directly upon the equator, heat enormous masses of air, which rise and flow north and south towards the colder regions of the poles, while colder currents flow in from both sides to the equator, become heated, and in their turn rise and spread outwards above. The energy of wind currents is thus also derived from the sun.

Let us think of the coiled spring, whence is its energy obtained? The spring was coiled by the strength of someone's hand. The person who turned the key expended energy, did work, in the act. But the energy liberated from the muscles of his hand and arm as he turned the key was not lost; it was being stored in the coiling spring, and would again be liberated in keeping the clock-work going. The energy of the person's muscle was derived from food consumed, and we shall see by and by (p. 528) that this energy too is in its origin traceable back to the sun.

Now let us return to the steam-engine; its energy is derived from pressure of steam, but how is the potential energy of steam at high pressure obtained? The steam is raised from water, placed in a boiler over a furnace in which fuel, let us say coal, is burned. It is the heat derived from burning coal that raised the steam so abundantly. So that the mechanical work done by the engine is derived, through pressure of steam, from the energy of heat. It appears, then, so far as the steam-engine is concerned, that the energy it liberates in doing work is derived from coal. The coal is the store of energy, a mass of potential energy, and, in the act of burning, its stored-up energy is liberated and appears, through the medium of the mechanical parts of the engine, as mechanical work. But how does the coal come to be a store of energy—what is coal? Of every pound of coal rather more than ⅘ths consist of the chemical element called carbon. Now carbon has a strong attraction for oxygen gas, the chief gas in ordinary atmospheric air. When carbon and oxygen unite, there is formed a third substance, which, in ordinary circumstances, is a colourless gas. This union takes place with such force that an enormous quantity of heat is produced. If any two bodies are caused violently to clash together heat is produced by the force of collision. If cold iron be rapidly hammered on an anvil, in a short time it will be perceptibly warm. The particles of carbon having a strong chemical attraction for the particles of oxygen gas, as soon as they get the opportunity they rush together, and the collision of the uniting particles liberates heat. So, at least, we may explain it to our minds. To this process of uniting with oxygen the terms **burning, combustion,** or **oxidation** are applied. If we were to express in scientific terms such an ordinary everyday fact as that "the fire burns," we might say "the coal is undergoing oxidation in the grate." It is not necessary to speak by the card in this way, but it is very necessary to remember that, when the fire burns, what is really happening is that the carbon, of which the coal mainly consists, is uniting with the oxygen contained in the air, with the result that carbonic acid gas, among other products, is formed and escapes up the chimney, and a great amount of heat is given off by the force of the chemical combination. In the case of coal the union with oxygen needs encouragement to begin with, and the needed encouragement is afforded by applying a light to the coal. Once it has made a start it goes on, however, vigorously, provided the supply of oxygen is plentiful, provided, that is, there is plenty of air, and a draft of air to bring fresh supplies to the fire. Everybody knows that, if the chimney "will not draw," the fire goes out, that is, there is not sufficient draft to bring fresh supplies of air (which contains the oxygen) quickly enough to permit the union to go on. If the fire is languishing, someone goes for the bellows and speedily blows the fire into a blaze; that is, by means of the bellows large quantities of oxygen are quickly driven into the fire, and the rate

of chemical combustion is so much increased that the heat becomes very great. It is in this process of union with oxygen, then, or oxidation process, that heat is liberated; and heat is liberated wherever that process occurs. The heat may not be perceptible if the process is slow, but wherever the process is very rapid the heat is great. We are thus enabled to understand that the energy of heat as thus derived is the result of the energy of chemical attraction.

But we have not yet answered fully the question of the source of the energy of coal. How did carbon come to be in the form of coal? Coal is derived from vegetable matter. Beds of coal were originally masses of vegetation, perhaps in some primeval forest. The vegetable matter has become covered over, and, under the influences of temperature, moisture, and pressure, chemical changes have gone on in the slow course of ages, which have resulted in converting the original plants, shrubs, and trees also, it may be, into masses of coal. The carbon, then, of the coal has originally formed part of the structure of a living plant. Now the carbon does not exist in the living plant in the simple form of the chemical element, but built up into highly complex compounds in the form of fats, oils, starches, and sugars. All these are compounds of carbon manufactured or built up by the plant in the course of its life. The plant obtains the carbon, which it thus builds up, from the atmospheric air, in which it exists in the form of the gas we have already mentioned, carbonic acid gas. That gas, we have seen, is a chemical compound of carbon and oxygen, and the plant seizes upon this compound in the air, splits it up, liberates the oxygen, retains the carbon and builds it up in its body into the complex fats, starches, &c. In this building-up process the plant does work, just as a man does work in lifting a weight or coiling a spring, and the energy it thus expends is stored up in its body in the starch or fat it has manufactured, just as a man stores up the energy, expended in lifting the weight or coiling the spring, in the weight he has lifted or the spring he has coiled. The plant, therefore, stores energy in the complex carbon compounds it produces. Where did the plant get the energy to do this? It has been shown that the plant can only separate carbon from the atmosphere and build it up in its own body *under the influence of the sun's rays.* Unless the sun's rays were poured upon it it would cease to do this and die. In the end it comes to this, then, and this is the important point, that the energy of the plant is derived from the sun, and that the energy of the sun's rays is stored up in the plant in the form of fats, oils, sugars, and starches, and such carbon compounds. This stored-up energy becomes, under the influence of temperature, pressure, &c., already referred to, the stored-up energy of coal. When we burn coal we liberate, by the agency of chemical combination, the energy which, countless years before, the plant had stored up from the sun's rays, and, by appropriate means, convert it into the energy of steam at high pressure, and then obtain it as work done in the form of mechanical motion.

Thus we find the energy of a head of water, of currents of air, and of coal, are ultimately derived from the sun, from which source there thus really proceeds practically all the power of doing terrestrial work.

In the case of coal we see a remarkable circle of changes similar to that observed in the case of a head of water. The plant stores the energy of the sun; in time the stored energy reaches us as coal. We burn the coal and liberate the energy. In this act carbonic acid gas is formed and passed into the atmosphere. The plant seizes upon the gas and under the influence of the sun again converts the carbon into a store of energy, to be again liberated, and so on.

Further, we have traced the building up of fats, oils, starches, and sugars in the plant to the energy of the sun. But these form a large portion of man's food, and the exclusive food of animals used by man for food—the ox, sheep, &c. The food of man is then the stored-up energy of the sun, which man takes into his body. In his body he liberates that energy in the form of heat and mechanical work, so that the energy he expends in lifting a weight, coiling a spring, &c., is energy derived originally from the sun.

The Conservation and Transformation of Energy.—In the preceding paragraphs we have had illustrations of the fact, the discovery and proof of which form one of the chief triumphs of modern science, that energy is never lost. When energy seems to disappear, in reality it does not do so; it simply assumes another form. The energy of chemical action may become transformed into the energy of heat, that of heat may assume the form of mechanical work. The energy expended in the form of mechanical work, as in lifting a weight, is not lost, but becomes potential energy of position, for the weight as it descends may do work or liberate heat and so on. Thus we have an idea of what is meant by the modern law of the

conservation of energy, the law which states that energy is never lost, and also of what is meant by the transformation of energy, which explains what takes place when energy seems to disappear. The right understanding of this is of the utmost importance in our study of foods.

The Energy of Heat and of Mechanical Work.—Let us return again to our illustration of the steam-engine. We have seen that the power of doing work possessed by the steam-engine is obtained from the coal in the form of heat. If it is true that energy is never lost, and if we suppose our engine to be a perfect one, so that all the heat given off from the coal is converted into work done by the engine, then the amount of work which the engine can do ought to be exactly measured by the amount of heat given off from the coal. Is this true? Does a certain amount of heat always represent a certain amount of mechanical work, so that given a certain amount of heat, one can calculate from it the amount of mechanical work, assuming that all the energy of heat is converted into work done? There is such a definite relation, and it was proved by two men, working independently of one another, Julius Robert Mayer (1842), a Schwabian physician, and James Prescott Joule (1845–1847), a manufacturer of Manchester. To determine the relationship, it is plain one must have to begin with standards of measurement for heat and work done, just as to determine the weight of any body one must have a standard of weight, namely, the pound weight. The standard measure of heat is the amount of heat necessary to raise the temperature of one pound weight of water at the freezing-point one degree on the Fahrenheit scale. This amount of heat is called the unit of heat, and is called the **calorie**, as the standard of weight is called the pound, or the standard of length the yard. Ten pounds weight of water heated by 1 degree Fahrenheit represent 10 heat units, or 10 calories. The standard of work is the amount of work done in raising a weight of 1 pound 1 foot high. This is the unit of work or the **foot-pound**. When a man raises a weight of 1 stone 1 foot high, he is said to do 14 foot-pounds of work, and if he raises 2 stones (28 pounds) 10 feet high, he does 280 (28 multiplied by 10) foot-pounds of work. Now, the question is, is there any exact relation between the calorie, or unit of heat, and the foot-pound, or unit of work? for if there is, it will be necessary only to measure how many units of heat are given off from the burning of 1 pound of coal to determine how much mechanical work can be got out of the energy thus liberated from the coal. Now, we have said that a man expends energy in raising a weight to a certain height, and the quantity of energy depends on the weight and the height to which he has lifted it; and further, that the energy thus expended is stored up in the weight; when the weight is allowed to fall the energy is liberated. If the weight have a cord attached to it and the cord be wound round some piece of clock-work, the liberated energy will be employed in doing work. If a weight of 10 lbs. be raised 50 feet, then it has stored up in it 500 foot-pounds of energy. Well then, to determine the relation between heat and mechanical work, Joule used an apparatus represented in Fig. 190.

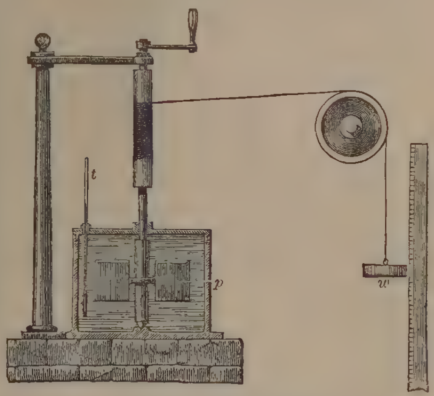


Fig. 190.—Joule's Apparatus for the Determination of the Mechanical Equivalent of Heat.

It consisted of a box in which, fixed to an axle, was a set of eight small paddles (*p*). The axle projected out of the box and had wound round it a cord, which passed over a drum, and connected to the cord was a certain weight (*w*). When the weight was allowed to fall, the drum revolved, the axle was turned and with it the paddles in the box. The box contained a weighed quantity of water, the temperature of which was taken. The revolving paddles agitated the water. A thermometer (*t*) fitted into the box dipped into the water. If the water became warmer the thermometer indicated the amount of heat. Joule allowed the weight to fall, causing the water to be churned, and then he found that, by the churning, the water was warmed. That is to say, the energy liberated by the falling weight, was transformed into the mechanical work of the revolving paddles, and that again was transformed into the energy of heat. Joule found that by a weight of 1 lb.

falling 772 feet, 1 lb. weight of water was raised one degree in temperature. That is to say, 772 units of work, or foot-pounds, were equal to 1 unit of heat or 1 calorie. We have seen that the energy liberated by a weight of 1 lb. falling 772 feet is the same amount of energy as is expended in raising 1 lb. 772 feet high. So that we might put the result thus: the amount of energy which, appearing as heat, will warm 1 lb. of water by 1 degree Fahrenheit, will, if converted into mechanical work, raise 1 lb. weight 772 feet in the air, or, what is the same thing, will raise 772 pounds 1 foot high. This number 772 is, therefore, called the **mechanical equivalent of heat.** In short, 1 unit of heat is equal to 772 units of work. If, then, a certain mass of coal yields 10 heat units, we can tell how much work it represents. Multiply by 772. The energy stored up in the coal, if all converted into mechanical work, will raise 7720 pounds 1 foot high, or 1 pound 7720 feet high. Similarly, if the weight of a ton has been raised 10 feet high, we can tell how much heat that represents. One ton is equal to 2240 pounds. That has been raised 10 feet, so that 22,400 foot-pounds of work have been done. But 772 foot-pounds are equal to 1 heat unit. Therefore 22,400 divided by 772 will give the amount of heat, in heat units, represented by the raising of the ton weight. It is equal to fully 29 heat units.

Here, then, is a means of determining the amount of energy stored up in any substance, such as coal, wood, oil, &c. It is only necessary to burn a given weight of the substance, say 1 pound, and to find how much water the heat produced will warm by 1 degree Fahrenheit. The figure obtained expresses the units of heat, or calories, yielded by the substance, and this, multiplied by 772, gives the mechanical work which the energy stored up in the 1 lb. of substance might perform, *supposing all the heat could be converted into mechanical work.*

Now, various observers have determined by experiments the amount of heat given off from very many different substances, so that there are now ready to one's hands the means of determining the value of these substances for the doing of work. The method by which the results were obtained it will be interesting to note. The instrument used to determine the amount of heat given off by a body in burning is called a **calorimeter**, or measurer of heat. It is represented in Fig. 191. It consists of a small chamber (C) within a much larger one (D). The space between the two chambers is filled with water, the quantity of which is measured. A thermometer (t) dips into the water to indicate the temperature. In the inner chamber is placed the substance to be burned. The heat given off in the process

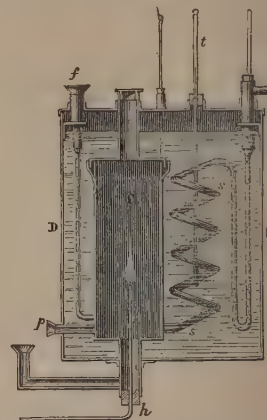


Fig. 191.—Dulong's Calorimeter for Combustion of Gases. The gas to be burned enters by h, oxygen for combustion by f or p, and the products of combustion pass off by the worm s, s.

of burning is communicated to the water, various careful arrangements being made to prevent it being otherwise lost. When all the substance has been burnt, the temperature of the water is read off, and as the quantity of water is known, the units of heat are readily ascertained. It has been determined by such means that 1 lb. of wood charcoal, if completely burned, will yield 8080 heat units, that is will raise the temperature of 8080 pounds weight of water by 1 degree Fahrenheit. This heat we have seen is the result of the chemical union of the carbon, of which charcoal consists, with oxygen. Now, there is a gas called hydrogen, which, when chemically combined with oxygen, forms water. This gas burns. It is its presence in ordinary coal-gas that makes the gas burn. When hydrogen is burned with a stream of oxygen a flame of most intense heat is produced. It is this flame directed on a cylinder of lime that gives the intense light, the lime-light, so commonly used for magic lanterns. One pound weight of hydrogen when completely burnt yields no less than 34,460 units of heat.

We see, then, what an enormous quantity of heat is given off by carbon and hydrogen, and we have learned how, from the quantity of heat, we can determine the value of these substances for the production of mechanical work. Anyone who thoroughly understands this is provided with the means of estimating the value of different substances used as food-stuffs.

Food as a Store of Energy.—In the previous paragraphs it has been necessary to notice that fats, oils, starches, sugars, are built up by the plant out of chemical elements, which they obtain from the atmosphere and also from the soil. Now these different kinds of food-stuffs all consist of three elements, carbon, hydrogen, and oxygen, but arranged and combined in a highly complex way. We have seen, moreover, that the building up of these elements implies the expenditure of energy, and that the energy expended in the process is stored up in the manufactured substances. If these substances be broken down and reduced to their elementary form, the stored-up energy will be liberated. This breaking down can be effected by the process of oxidation or burning, by which the carbon unites with oxygen to form carbonic acid gas, and the hydrogen unites with oxygen to form water. The oxygen contained within the substances themselves is used for the process, but is not sufficient, and more requires to be supplied from without. In the oxidation process, whether it takes place rapidly or slowly, the stored-up energy is released in the form of heat, and from the quantity of heat liberated can be estimated, in the way already described, the value of the food-stuff for the production of mechanical work. This is true not only of the fats, starches, &c., that may be stored up in a plant, which, from one point of view, may be considered as something apart from the body of the plant itself, but is true also of the tissue of the plant itself, of the living matter or protoplasm of the plant, within which the living processes of the plant are accomplished. The protoplasm or living tissue of plants, as of animals, consists mainly of four elements, the three already named, carbon, hydrogen, and oxygen, and another of infinite importance, nitrogen, along with sulphur and sometimes phosphorus. If a plant be burned, the protoplasm becomes oxidized into carbonic acid gas, and water, and also into ammonia, the ammonia containing all the nitrogen, which had existed in the organized matter of the plant, the oxidation being accompanied as before by the liberation of energy in the form of heat. Animals feed on plants, some of them exclusively, and build up the compounds found in the vegetable food into still more complex substances in their own body, forming thereby muscle, blood, bone, fat and so on. Part of the food is never built up into the body of the animal, but stays in the body only long enough to be broken down into simpler and unorganized bodies, in order that the energy contained within it may be liberated for the use of the animal. Man consumes as food both vegetable and animal structures, uses it partly to build up the structure of his own body, and breaks part of it down into elementary substances in order to obtain from it the stored energy it contains. Food, then, whether animal or vegetable, consists of elementary substances built up into complex forms, and the energy which it thus contains may be liberated as heat by the process of burning. Various experiments, conducted by Professor Frankland, of the Royal School of Mines, and others, have been carried out for the purpose of accurately determining the value of different food-stuffs for mechanical work by the amount of heat liberated from them in process of combustion. The method adopted was that of the calorimeter already described. The following table gives the results obtained by Frankland. It expresses the amount of heat in heat units obtained by completely burning in the calorimeter 1 lb. of each substance named. The food-stuff was employed in its natural condition, that is without previous drying, unless when stated to the contrary.

Name of Food-Stuff.	Heat units per lb.[1]
Cod-liver oil,	9107
Butter,	7264
Cocoa nibs,	6873
Cheese (Cheshire),	4647
Bread-crust,	4459
Oatmeal,	4004
Flour,	3936
Pea-meal,	3936
Arrow-root,	3912
Ground rice,	3813
Yolk of egg,	3423
Lump-sugar,	3348
Commercial grape-sugar,	3277
Hard-boiled egg,	2383
Bread-crumb,	2231
Ham (boiled),	1980
Mackerel,	1789
Beef (lean),	1567
Veal,	1314
Guinness's stout,	1076
Potatoes,	1013
Whiting,	904
Bass's ale,	775
White of egg,	671
Milk,	662
Apples,	660
Carrots,	527
Cabbage,	434

[1] Frankland used the French thermometric scale, the Centigrade scale. To heat 1 lb. of water by 1° on the Centigrade scale requires 1389 units of work, while, as we have seen, 772 is the figure for the Fahrenheit scale. To convert heat units on the Centigrade scale, therefore, *multiply* by 1389, and to convert units of work into heat units on the same scale *divide* by 1389.

By performing the appropriate calculation we might express the value of the energy liberated from each substance in terms of mechanical work. Thus from these figures we find that the total energy liberated from 1 ounce of butter would, if all could be converted into mechanical work, raise 281 tons 1 foot high.[1] Other illustrations are given in the table.

1 ounce of	butter	is equal to	281	tons raised 1 foot.
,,	oatmeal	,,	152	,,
,,	beaf (lean)	,,	55	,,
,,	milk	,,	24	,,
,,	carrots	,,	20	,,
,,	cabbage	,,	16	,,
		&c.	&c.	

If one carefully examines this list, one or two points of great interest speedily reveal themselves. The first glance shows that fats and oils head the list, they yield the greatest amount of energy. Cocoa nibs rank very high; but when we examine the composition of cocoa nibs we find they contain 50 per cent of fat, so that it is really because of their contained fat that they have so great value as stores of energy. Next to the fatty substances come the starchy. Arrowroot consists mainly of starchy material, while flour consists of starch to the extent of nearly 75 per cent, and meal to 63 per cent. If we ask how oatmeal has a higher value than flour or arrow-root, the answer is that oatmeal contains also 10 per cent of fat, while flour contains less than 1 per cent, and arrow-root contains none. It is, then, the fat in oatmeal that causes it to rank above flour, &c., as a store of energy. Again look at the difference between yolk of egg alone and the whole egg in the amount of energy they yield. Here again it is a question of fat. In the yolk of egg there is 30 per cent of fat, but when one takes white and yolk mixed, as the white contains no fat, the percentage of fat in the whole is reduced to 11. Thus 1 lb. of yolk is of more value, as a store of energy, than 1 lb. of mixed white and yolk. It is a similar circumstance that gives to mackerel a higher value as a store of energy than is possessed by whiting. Mackerel contains fully four times the quantity of fat that whiting does. Thus the list shows that, regarding food-stuffs as stores of energy, fats take the highest rank, starchy and sugary food-stuffs come next, and meaty substances (lean beef), &c., are poorer in the amount of energy they yield than either. This has been further shown by the results of actual experiments on dogs, in which it was found that

100 parts of fat yielded as much heat and energy for work as
232 ,, ,, starch,
234 ,, ,, cane-sugar,
and 243 ,, ,, lean meat.

Is there any reason for this high value of fat as a source of energy? When fat is analysed it is found that of every 100 parts

79 consist of carbon, and
11 ,, of hydrogen

and only 10 of oxygen. That is 90 of the 100 parts are combustible or oxidizable substances. Starch, on the other hand, contains in every 100

45 parts of carbon and
6 ,, of hydrogen,

a total of 51 parts only of combustible substance, the remaining 49 consisting of oxygen with which the burning is partly effected. Sugar consists of

43 parts carbon, and
6 ,, hydrogen

in the hundred, a total of 49. The enormous quantity of heat liberated by the burning of carbon and hydrogen has been already indicated (on p. 530), and when we find fat containing 90 parts in 100 of these elements as against 51 in starch and 49 in sugar, the reason of the high value of fat as a source of energy is apparent.

Now it will naturally occur to everyone, who considers the figures that have been given, that the amount of energy represented as mechanical work given off, from the burning of the food-stuffs named, is too great for belief. It seems absurd to think that 1 ounce of butter will yield heat, which, if transformed into work done, will raise 281 tons 1 foot high. The amount of heat stated is actually given off, and has been determined, as stated, by actual experiments in the calorimeter. In estimating the mechanical work that heat represents, it has been assumed that *all the heat is transformed into mechanical work*. But, as a matter of fact, no engine has been devised, or can be devised, capable of utilizing all the heat obtained from the burning of the fuel, and converting it into mechanical work. In the most perfect machine yet constructed it has been found possible to convert

[1] 1 lb. of butter gives 7264 heat units. To get the equivalent in mechanical work, multiply by 1389. The result is 10,089,696 in foot-pounds per *pound* of butter. That is equal to 630,606 foot-pounds per *ounce* of butter. 630,606 divided by 112 expresses the same amount in hundredweights, namely 5630; and that again divided by 20, expresses the amount in foot-tons, namely 281.

only $\frac{1}{8}$th part of the heat into work. It is the aim of engineers to construct engines that will utilize as much of the heat as possible, and yet this is the best result they have obtained. They do not wish the engine to become heated, for that means wasting the energy of the fuel. In the animal body the energy derived from food is converted into mechanical work to a much greater extent than can be effected by any steam-engine. It has been estimated, for example, that the horse can transform 32 per cent of the energy obtained from food into work, that the ox can transform 43 per cent, and man can transform 53 per cent. So that in this respect the human body is far ahead of the most perfect engine that man has yet been able to construct. But, in the case of the animal body, the energy of food that appears as heat, and is not transformed into work, is not lost. It is necessary to heat the animal body and to maintain its warmth at a certain degree, which is usually higher considerably than that of the external temperature. Because the body is continually in contact with an atmosphere colder than itself, a large quantity of heat is continually being given off from the body. Heat is constantly being lost in the evaporation of the sweat, in heating the air given out from the lungs, in heating the discharges from the body, &c. The quantity of energy consumed in this way, in 24 hours, has been calculated as equal to 2,839,000 units of heat, or a heat sufficient to raise about 62 pounds of water from freezing-point to boiling point (Gamgee). But energy is not only being constantly expended in the body in this way, it is also being expended in large amount in doing work of which there is no external sign. The heart is regularly contracting, driving the blood through the body. The work it does "might be estimated without exaggeration as at least equal in 24 hours to the work expended in lifting 120 tons to the height of 1 foot, while almost certainly it would greatly exceed this estimate. That is to say, that the heart of a person, who is almost absolutely at rest, does an amount of work which is a sensible fraction of the *external*, or, to use a popular expression, the *manual* labour performed in the working day of a hard working labourer." Over and above this, there is the work being regularly done by the muscles of respiration in expanding the chest against considerable resistance. If all these things are taken into account, it will become apparent that there will not be left over a very large balance of energy derived from the food for the performance of external work. Moreover, one must not forget that when a man simply walks about he is transporting the weight of his body, and when he walks up a stair he is raising the weight of his body so many feet into the air. Thus a man weighing 11 stones (154 lbs.) going up a step 6 inches high, does 77 foot-pounds of work in carrying up his body, and if he goes up a stair of 12 steps 20 times a day, in this exercise alone he does 16 foot-tons of work. The same man in walking one mile does nearly 17$\frac{3}{4}$ foot-tons of work in the mere transporting of his own weight.

All this time we have been arguing from figures derived from the burning of food-stuffs in the calorimeter. It is time now to say that it appears that food-stuffs undergo a precisely similar change in passing through the body to that they undergo in the calorimeter. The change, that is the combustion or oxidation process, as carried on in the calorimeter, is very much more rapid than the change as accomplished in the body, but the results are the same. Fats, starches, and sugars, are burnt to carbonic acid gas and water in the body, just as they are outside of the body, and the carbonic acid gas and water are, thereafter, expelled from the body as waste products. Whether the process be rapid or slow, the total energy liberated, when the process has been completed, is the same. The figures derived from the calorimeter may, therefore, with perfect propriety, be applied to the human body. There is an exception. Meat does not undergo complete combustion in the body. The figures obtained from the experiments are, in consequence, too high for it. Corrections for this are, however, easily made. This it is not necessary for us further to consider.

Now we must return once more to the illustration with which this section opened. We said the human body could be compared to a steam-engine in thorough working order, and that to maintain it in good condition it was necessary (1) for the tear and wear of its parts to be maintained, and (2) for energy to be imparted to it for the doing of work. We have seen that the energy is derived from the combustion of coal in its furnace. This induced us to consider the nature and sources of energy, and we naturally went on to consider food as a source of energy to the human machine, for the human body may also be viewed as a machine for doing work. In the doing of work some of its parts are subject to tear and wear, which, if the human machine is to be kept in good working order—that is, in good health—must be speedily re-

paired. In the second place, it must be supplied with energy.

This, then, is the twofold business of food, (1) to repair the tear and wear of the human machine, and (2) to yield energy by which it may do its daily work. Having seen, generally, how food is fitted to yield energy, we must next notice how food is fitted to repair tear and wear. Suppose a steam-crane is engaged lifting heavy loads for an hour on end. During the process two things have happened; (1) steam has been allowed to escape from the boiler into the cylinder to work the piston—that is, energy has been liberated, and to a slight extent—a very slight extent—the working parts of the machine have been worn. The energy for lifting the weight has not been obtained from the wear and tear of the machine, but from the steam. Now substitute a man for the steam-engine, and suppose him to work for an hour on end wielding a heavy hammer. He has lifted the hammer regularly by the repeated contractions of some of the muscles of his arm, and in these muscles two things have happened; (1) energy has been liberated within the muscles by the combustion or oxidation or burning of some substance contained in the muscles, and (2) the muscles, to a slight extent—a very slight extent—have been worn. That is to say, while the muscles have actually suffered some wear and tear by this work, the energy liberated in the muscles need not have been produced by the breaking down of some of the actual fibres of the muscle, but only of some substance contained within the muscle. It is plain, then, that there may be some considerable difference between supplying the material out of which energy is obtained and the material out of which the wear of the muscle is repaired. Whether there be any difference or not, there is only one source from which both kinds of material are obtained, and that source is food supplied. It is also perfectly plain that if the food supplied is to be sufficient for the rebuilding of wasted muscle, it must contain all the materials of which muscle is found to consist. The same is true of every other part of the body. In the working of the bodily machine the bones suffer some tear and wear. It may be slight, but the wear and tear, nevertheless, occur, and the food supplied must contain the elements of which bones are made. Nerves suffer waste, and every tissue of the body; and thus food must contain all the elements of which every organ and tissue of the body are built up. If it does not, some tissue of the body will not be supplied with material for repairing its wasted portions, and a catastrophe will, sooner or later, occur. In order to understand what kind of food is fitted for such purposes, we must, therefore, have some kind of knowledge of the composition of the human body.

THE CHEMICAL COMPOSITION OF THE HUMAN BODY.

Chemical Elements found in the body.—All the various complex substances found in nature can be reduced by chemical analysis to simple substances, and when they have been reduced to their simplest forms and cannot be any further split up, there remain seventy elements. By combinations of these seventy elements, of various kinds and in various proportions, all the substances known to exist in the world of nature are built up.

A human body, when dead, may be submitted to chemical examination just as a handful of earth, a piece of rock, or any other substance may be. When that has been done it is found that blood, muscle, nerve, bone, skin, hair, teeth, &c., may also be reduced to similar elements—that, in fact, the human body is built up of a few of the same seventy elements that are found in nature. Of the seventy elements only fourteen are found in the human body, namely, **oxygen, hydrogen, nitrogen, chlorine, fluorine, carbon, phosphorus, sulphur, silicon, calcium, potassium, sodium, magnesium, and iron.** Some of these elements, as they exist in their elementary form, are gases, others are metals, while the remainder are non-metals. This may be shown as follows:—

Elements found to exist in the Human Body.

Oxygen, Hydrogen, Nitrogen, Chlorine, Fluorine.	Gases.
Calcium, Potassium, Sodium, Magnesium, Iron	Metals.
Carbon, Phosphorus, Sulphur, Silicon	Non-Metals.

Besides these, excessively minute quantities of other elements, such as manganese, copper, lead, &c., have been found, but probably they are only accidentally or temporarily present, and did not enter into the actual constitution

of the body. They may, therefore, be neglected. Silicon is in a similar position though it appears on the list.

It is interesting to note the proportion in which these various elements are present, and that is shown in percentages in the following table:—

Oxygen ...	... ... 62·430	per cent.
Carbon ...	... ... 21·150	,,
Hydrogen	... ... 9·865	,,
Nitrogen	... ... 3·100	,,
Calcium	... ... 1·900	,,
Phosphorus	... ... 0·946	,,
Potassium	... ... 0·230	,,
Sulphur ...	... ... 0·162	,,
Chlorine	... ... 0·081	,,
Sodium ...	... ... 0·081	,,
Magnesium	... ... 0·027	,,
Iron ...	... ... 0·014	,,
Fluorine	... ... 0·014	,,
	100·000	

Oxygen, hydrogen, and nitrogen, as we see from the preceding table, are gases in their uncombined state, and yet they form three-fourths of the weight of the whole human body. Carbon is a solid. Charcoal, lampblack, black-lead, are impure forms of it. It forms more than a fifth of the whole weight of the body. Carbon and the three gases named thus form over 96 per cent of the total weight of the body.

Chemical Compounds found in the body.—It is necessary very carefully to note that, with slight exceptions, none of these elements exist *in their elementary form* in the body; they are combined with one another in various ways and proportions to build up more or less complex substances, differing widely from the elements of which they consist. The slight exceptions are oxygen, hydrogen, and nitrogen. Though the bulk of all three exists in combinations of various kinds, yet a small quantity of oxygen exists uncombined, but in solution, in the blood, a small quantity of nitrogen is also found in solution in the blood, and small quantities of all three exist free in the intestinal canal.

Water.—Now oxygen and hydrogen unite to form water; and water is found in the human body to the extent of over 60 per cent.

Inorganic Salts.—Further, a large number of the elements named are found uniting with one another to form inorganic salts, salts found existing in nature, which do not need the agency of any living thing, any organized structure, to cause them to combine, but do so simply by the force of chemical affinity.

The best example of this kind of compound is common salt, a compound of sodium and chlorine, called, therefore, in chemical language, chloride of sodium. It is found in all the tissues and fluids of the body, and is one of the most important inorganic substances the body contains, and is absolutely necessary for continued existence.

Chlorine, besides uniting with sodium, forms a salt in conjunction with potassium, the chloride of potassium, and forms, with nitrogen and hydrogen, the chloride of ammonium, ammonia being a compound of nitrogen and hydrogen. These are found in the body.

Other salts are found in the body, of great importance being those formed by a combination of phosphorus with sodium, with potassium, with calcium, and with magnesium, forming the phosphate of sodium, phosphate of potassium, phosphate of magnesium, and phosphate of calcium (phosphate of lime). This last, phosphate of calcium (that is, phosphate of lime), is the most abundant of the salts of the body. It forms more than half of the bones, and is found in considerable quantity in teeth, and it exists in other solids and in fluids of the body. It is present in milk to the extent of 2½ per cent. Associated with it in bones and teeth is a compound of calcium with carbon and oxygen, carbonate of lime.

Sodium combined with carbon and oxygen exists in the body as carbonate of sodium, and with sulphur and oxygen as sulphate of sodium.

Potassium also exists as sulphate of potassium.

Fluorine and calcium are found united as fluoride of calcium in the bones and teeth, though in very small amount.

If all these compounds, forming salts or mineral matters, that exist in the body, be summed up together, they are found to constitute about six per cent of the whole body weight.

Thus, so far as we have gone, we see the human body consists of:—

Water about ... ... 61 per cent.
Salts or Mineral Matters ... 6 ,,

Namely—*Chloride of Sodium.*
,, of Potassium.
,, of Magnesium.
,, of Ammonium.

Phosphate of Lime.
,, of Sodium.
,, of Potassium.
,, of Magnesium.

Carbonate of Lime.
,, of Sodium.

Sulphate of Potassium.
,, of Sodium.

Fluoride of Calcium.

A compound of hydrogen and chlorine, hydrochloric acid, is found existing as such in the digestive juice of the stomach.

Organic Compounds.—Now, over and above these substances, there exists in the human body a series of compounds not found in the lifeless or inorganic world, substances formed of the union of the same elements that have been named, but which require for their compounding the agency of living structures. For that reason these compounds are called **organic.** Moreover, man and the lower animals cannot compound them, or build them up from the elements. That is done by plants. Man and the lower animals take the organic materials they require from the vegetable world, and so the structure of the animal kingdom, including man as the most imposing portion of the edifice, rests upon the vegetable kingdom as its foundation. The organic materials which animals and men take from the vegetable kingdom they build up into still more highly organized forms in their own bodies.

The organic materials found in the human body fall principally into three classes:—

Proteid or Albuminous Substances.
Carbo-hydrates (that is, Starches, Sugars, and Gums).
Fats.

The elements built up into proteids are carbon, hydrogen, oxygen, and nitrogen, with sulphur; the elements built up into carbo-hydrates are carbon, hydrogen, and oxygen; the elements built up into fats are also carbon, hydrogen, and oxygen. The important distinction between the first and the other two classes is that proteids contain the element nitrogen which the others want. Proteids are, therefore, called **nitrogenous,** and the others **non-nitrogenous** substances.

Further it will be noted that both the carbohydrates and the fats are built up of the same three elements, carbon, hydrogen, and oxygen. Though formed of the same three elements, these two classes differ markedly from one another. The difference between the two consists, for one thing, in the very widely different proportions in which the elements are combined in the two kinds of food-stuffs, a difference which chemistry can reduce to figures. But it also consists in the manner in which the elements are combined, just as stone, wood, and lime may be built up into two houses of very different form, and not the least resembling one another. It may now be convenient to put in tabular form the knowledge thus far gained.

The human body contains thirteen elements built up into various compounds, as follows:—

			Built up of
Inorganic—			
		Water ..	Hydrogen and Oxygen.
		Salts ...	Hydrogen, Oxygen, Nitrogen, Carbon, Calcium, Phosphorus, Potassium, Sodium, Sulphur, Chlorine, Magnesium, Iron, Fluorine.
Organic—			
Nitrogenous		Proteids	Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur.
Non-nitrogenous		Carbo-hydrates	Carbon, Hydrogen, Oxygen.
		Fats ...	Carbon, Hydrogen, Oxygen.

We must consider the organic substances for a little.

Proteids consist, as already mentioned, of carbon, hydrogen, oxygen, nitrogen, and sulphur. The type of proteids is egg albumin, white of egg. These proteid or albuminous bodies are found in muscle, in nerve, in glands, in blood, and in nearly all the fluids of the body. The albuminous body of muscle is called **myosin,** that of the fluid part of blood is **serum-albumin,** that of coagulated blood is **fibrin,** the red corpuscles of the blood are formed of **hæmoglobin,** which contains an albuminous body.

Milk contains two albuminous bodies, the chief of which is **casein,** which forms the curd, and is the main constituent of cheese. Proteid bodies occur in various forms in vegetable structures; the proteid of cereals, wheat, corn, &c., is called **glutin,** that of peas is **legumin.**

Other forms of proteids exist. Thus, in bones, and connective tissues like tendon and skin, a proteid body exists which, on boiling, yields **gelatin.** Gristle (cartilage, p. 23) yields another proteid called **chondrin.**

Of proteid substances a human body is estimated to yield on an average about 18 per cent.

Carbo-hydrates are formed of carbon, hydrogen, and oxygen, the last two being in proportions to form water. Starch is a carbo-

hydrate, and is found in the body in the form of **glycogen** or animal starch, supposed to be formed by the liver (see p. 147). Sugar is another of this class, and is found as **grape-sugar** in blood and liver, **muscle-sugar** or **inosite** in muscle, and **lactose** or **milk-sugar** in milk.

This class exists largely in the vegetable kingdom. Thus potatoes, rice, sago, &c., consist largely of starch. Sugar is found in fruit as **laevulose**: there is **grape-sugar**, of which honey mainly consists, derived from the sweet juices of fruits and flowers, and **cane-sugar. Gum** and **cellulose**, obtained from plants, are also carbo-hydrates.

The carbo-hydrates in the body are estimated at a fraction of one per cent of the total body weight.

Fats are formed of carbon, hydrogen, and oxygen, in which the two latter are not in proportions to form water. There are three kinds of fat in the body—**stearin**, of which ordinary tallow candles are made, **olein**, the chief ingredient of olive-oil, and **palmitin**. The fat of the human body consists of a mixture of these three, and is liquid at the ordinary temperature, the olein keeping the other two in solution.

The body of an average man contains about 16 per cent of fats.

Now, while it is said that a human body consists of so much water, so much salts, so much proteid material, so much carbo-hydrates, and so much fat, it is not to be supposed that these exist in a condition easily separable from one another.

Take a piece of the red flesh (muscle), it does not only contain proteids but also water, salts, carbo-hydrates, and fats. They are blended or mixed together, as it were, in the muscle, and in different cases the amount will vary. Fat exists in the muscle even though it be not visible to the naked eye; the microscope will show minute fat cells (see p. 17) between and among the muscular fibres.

It requires to be noted that, though the proteids are the principal kind of nitrogenous substances existing in the body, they are not the only ones.

The ferments concerned in digestion, the ptyalin of the saliva (see p. 143), the pepsin of the stomach juices (see p. 143), &c., are nitrogenous also. The colouring matters of the body, that of the blood and red flesh, and those of the bile are also nitrogenous substances. Moreover, as a result of the tear and wear of the body, and the consequent breaking down of the tissues that constantly goes on, a variety of substances is formed from proteids also containing nitrogen. Thus there can be extracted from ordinary red flesh, by means of water, a variety of nitrogenous substances, of which kreatin, kreatinin, sarcin, are the names of some. On this account they are called **extractives.** It is the presence of some of these that gives to flesh its peculiar flavour. Two other important substances produced from the breaking down of nitrogenous substances, and containing nitrogen, are urea and uric acid, found in the urine. Though found in the body, they are to be regarded as unavoidable rather than necessary constituents, since they are the result of tear and wear. In nerve tissues, as another example, are found substances called protagon, cerebrin, &c., supposed to result from nervous activity, which are also nitrogenous. In the same way the changes undergone by sugars, fats, &c., in the body, produce a series of substances that need not be named here. Though constantly found, they are not essential constituents of the body.

Briefly, then, we may put the matter thus, the human body is composed of thirteen elements, built up into compounds. The compounds may be grouped into the following classes—water, salts, proteids, carbo-hydrates, and fats. These five classes of compounds, existing as such in the body, are called the **proximate principles** of the body, and the proportion in which they exist is summarized in the following table:—

Percentages of Proximate Principles in the Body.

Water, ...	61·0	per cent.
Salts, or mineral matters,...	5·5	,,
Proteids, ...	18·0	,,
Carbo-hydrates, ...	0·1	,,
Fats, ...	15·4	,,
Total, ...	100·0	,,

Or we might put it thus:—

The body of a man weighing 148 pounds will contain of

Water, ...	90·0	pounds.
Salts, ...	8·3	,,
Proteids, ...	26·6	,,
Carbo-hydrates, ...	0·1	,,
Fats, ...	23·0	,,
Total, ...	148·0	,,

THE NATURE AND CHEMICAL COMPOSITION OF FOOD-STUFFS.

In the paragraphs in which we have considered the constitution of the human body, we

have really laid down the elementary conditions which all food-stuffs must fulfil if they are fitted to maintain the body in a healthy condition as a good working machine. We may now state these elementary conditions in as brief a manner as possible:

1. Food-stuffs must contain all the elements found built up into the various organs and tissues of the body, else they will not be sufficient to repair the waste going on in the body.

2. These elements are thirteen in number, chief among them being carbon, hydrogen, oxygen, and nitrogen.

3. The animal body cannot make use of these substances in their elementary form. The elements must be built up into compounds, more or less complex.

4. The elements are built up first by the agency of plants, acting under the influence of the sun's rays. The lower animals, used by man as food, consume plants, and build up the materials they contain into still more complex bodies. Then man uses both plants and animals as food, and builds up what they supply into the material, blood, bone, flesh, nerve, skin, &c., of his own body.

The Classification of Food-stuffs.—On page 536 it has been stated that all the tissues of the body, and nearly all the fluids, contain proteid substances in their composition, and that proteids, besides carbon, hydrogen, and oxygen, contain *as an essential element, nitrogen.* No food-stuff, therefore, which fails to contain nitrogen can be sufficient for repairing the tear and wear of the bodily machine. Besides, it has been pointed out (p. 530) that carbon and hydrogen yield, when burnt, enormous quantities of heat, that is to say, liberate large quantities of energy. So that food-stuffs, which consist mainly of carbon and hydrogen, and which contain no nitrogen, while quite insufficient for repairing wasted portions of the body, are most valuable for yielding to the body the energy for the performance of its work. Here, at once, we are provided with a principle of classifying the food-stuffs obtained from the vegetable and animal kingdom. Applying this principle we divide food-stuffs into

NITROGEN-CONTAINING or NITROGENOUS,	to which belong **Proteids**	necessary for repairing tear and wear of the body.

and

CARBONACEOUS or NON-NITROGENOUS,	to which belong	Sugars, Starches, Gums, Fats,	specially valuable for the liberation of energy for work.

We must avoid the mistake, however, of supposing that nitrogenous food-stuffs are only useful for repairing tear and wear, and are always built up into the substance of the body. They contain, as we have seen, carbon and hydrogen, as well as nitrogen, and may thus be consumed in the body solely for yielding energy, without having previously been transformed into any of the living tissue of the body, muscles or bone or nerve, &c. All we assert is that muscle, bone, nerve, blood, &c., cannot be formed without them, since they only of food-stuffs contain the necessary element, nitrogen. This does not imply that they are always so built up. A quantity of proteid food may be eaten greater than is necessary to repair the tear and wear. In such a case the excess will undergo combustion in the body and will thus yield energy. Similarly we must not suppose that carbonaceous foods are used simply to yield energy, and are never built up in the body. For we have seen that the body contains a proportion of such compounds, and as they will also undergo waste they must be renewed from the food. What we do assert is that such substances yield energy in largest amount, and are the most useful forms of food material for the doing of work.

When we are reminded that the human body consists to a large extent of water, and to a small extent also of saline material or mineral substances, the necessity of these being present in food-stuffs is apparent. Thus the food-stuffs needed by man fall into the same five classes of compounds as the substances forming his body (p. 536). They are called the **proximate principles of food, or alimentary principles,** namely:

Inorganic	1. Water.		
	2. Salines or Mineral Matters.		
Organic	3. Nitrogen-containing or Nitrogenous.	Proteids	
	4. Carbonaceous or Non-nitrogenous.	Carbo-hydrates	Sugars. Starches. Gums.
		Fats	

The Fate of Various Food-stuffs in the body.—It may not be uninteresting to state a few of the reasons which have led to the general conclusions that have been indicated. A brief

consideration of the grounds of the conclusions will help to give a better appreciation of the relative value of the different foods, will supply the reasons for varying the kind of food taken under different circumstances, and will afford a more connected idea of the ultimate fate of the different foods in the body.

The Use of Water.—Regarding water not much more need be said. It undergoes no transformation in the body, we may say. But when we consider that the body loses daily about 10 ounces of water in the form of vapour given out in the breath, about 2 lbs. weight daily in the form of sweat from the skin, and from 50 to 60 ounces daily in the form of water given off from the kidneys, the need of replacing that loss is apparent. We shall see that all our food-stuffs contain a proportion of water in their composition, some of them consisting of water to the extent of three-fourths, and thus we are restoring water to the body with every bite we eat, as well as by the water we drink as such, or in beverages such as tea, coffee, &c.

The Use of Salines.—Salts of various kinds are also given off from the body in the perspiration (p. 309), in the excretion of the kidney, &c. (see p. 292), and they must be restored to the body.

The most familiar of the mineral substances we use in our food is common salt, or chloride of sodium (see p. 535). We know how wanting in pleasurable taste are most food-stuffs which are deficient in common salt, and how freely we add it to our food. There are, however, other saline substances always present in food-stuffs which are equally essential to the bodily well-being, though not required to the same amount. The process used in preserving food by pickling removes a considerable proportion of such saline substances from the food. If such preserved food forms nearly the exclusive diet for any length of time, serious effects on the health of the persons are produced. It is in such circumstances that scurvy appears among ships' crews. That this state of bad health is the result of the absence from the food of certain mineral substances is plain from the fact that if fresh vegetables, which are rich in the salines, be freely supplied, or in their absence other substances containing the salts, such as lime-juice, restoration of health results. A definite proportion, then, of saline substances in the food, seems necessary for the proper performance of the nutritive processes in the body.

The Use of Proteids.—The fate of proteids in the body was for a long time the subject of controversy. Liebig's view was that proteids were built up into the tissues of the body, into the flesh of muscle, &c.; and that when work was done it was done at the expense of the muscles, parts of which were broken down or underwent waste by the exertion, and thus proteid food was needed to repair this waste. If this were so it would imply that with increased work there would be increased waste of tissue and need for increased supplies of proteid foods, such as beef, fish, &c. It is extremely interesting to follow the steps by which the accuracy of this view was tested. Proteids, we have seen, are nitrogen-containing substances. If work is done at the expense of proteids then the nitrogenous waste of the body will be increased. Now, practically the only channel by which nitrogenous waste is expelled from the body is the kidneys, and it is expelled in the form of the nitrogenous body urea, the chief ingredient of the urine. If, then, work is done at the expense of proteids, at the expense of the tissues of the body, with increased work there will be an increased amount of urea expelled by the kidneys, and with less work there will be less urea expelled. In fact, the amount of urea expelled will depend on the amount of work done. This has been found not to be the case. Two German professors, named Fick and Wislicenus, made a direct experiment upon themselves. They ascended a mountain, 6561 feet high, and estimated the quantity of nitrogen given off as urea from the body during the period of their exertion, and they compared the quantity with the amount of urea given off from the body before the ascent began and after it was ended. In order not to cause errors by the kind of food taken, they ate no nitrogen-containing food for a whole day before the ascent, nor indeed any food of this kind till after the ascent was over, when they rested and took a liberal meal of meat, &c. The following is the result in the case of Fick:—

Before the ascent,	9·7	grains	nitrogen	per hour.
During ,,	6·3	,,	,,	,,
After ,,	6·1	,,	,,	,,
During the night,	6·9	,,	,,	,,

This shows that the work was not done at the expense of the tissues, else the quantity of nitrogen given off from the body would have increased. The fall in the quantity of nitrogen was due to the abstinence from nitrogenous food, and the increase during the night was in conse-

quence of the meal containing nitrogen taken after the ascent.

This result has been abundantly corroborated by later experiments. Thus, a set of observations was made on a watchmaker in the Physiological Laboratory of Munich, who was placed under three conditions. In one of the observations he received for a time no food and did no work, in a second he received a liberal diet and did no work, and in a third he received a liberal diet and did hard work. The quantity of nitrogen in the food given was estimated, and the quantity given off from the body was noted. If the quantity given off exceeded that of the food, it meant waste of tissues, loss of flesh, and the amount of flesh lost could be calculated from the excess of nitrogen expelled from the body. If as much nitrogen was not expelled as was given in the food, the conclusion was that the balance had been built up in the body, that is, the man had gained flesh, and the gain could also be calculated. Fat is very rich in carbon, and from the quantity of carbon given in the food, and the quantity given out as carbonic acid in the breath, it could be decided whether the body had gained or lost carbon. If the quantity given out exceeded that introduced as food, it was interpreted to mean that some of the stored-up fat of the body had been consumed and the man had lost fat. If the quantity given off were less, it meant that some had been stored as fat, and the man had gained in fat. The results were as follows:—

During the period of—

No food and no work the man lost 11 ounces of flesh and 7⅜ ounces fat,

Liberal diet, no work, the man gained no flesh, but 2⅓ ounces fat,

Liberal diet, hard work, the man lost no flesh, but 2 ounces fat.

Work is, therefore, not done at the expense of the built-up tissues, but at the expense of carbonaceous compounds stored up, specially fat, but also carbo-hydrates, such as starch and sugar.

It appears, then, that a certain amount of tear and wear of the tissues goes on irrespective of what amount of work is done, and that this amount is not materially increased with increased work, even with hard work, so that if a certain quantity of proteid food is given per day, sufficient to repair the waste, all that is further needed is a quantity of energy-yielding food, such as fat, starch, and sugar, which should be varied according to the work done, that is, the energy expended.

Supposing more proteid food is given than is necessary to repair tear and wear of tissues, what happens to it? The excess undergoes direct combustion in the body without previous building up into tissue, and thus will yield energy and heat. It appears that some of the excess may even be transformed into, and stored up as, fat. For proteids consist, as we have seen (p. 536), of nitrogen with carbon, hydrogen, and oxygen. When proteid has been consumed in the body, the waste, as we have said, is urea, and the urea contains all the nitrogen that was present in the proteid, but it does not contain all the carbon or hydrogen. Two-thirds of the carbon and hydrogen do not appear with the expelled urea. It seems, then, that, in the body, when proteid is consumed or undergoes combustion, it splits up into two parts, one containing all the nitrogen and a third of the carbon and hydrogen, which is expelled as urea, and another part containing the remaining two-thirds carbon and hydrogen. If this remainder be not immediately consumed to yield heat and energy, it is surmised that it may be built up in the body and stored as a carbonaceous body, such as fat, or a carbohydrate, like glycogen (see p. 147). Thus dogs fed on lean meat may gain in weight by the laying on of fat, derived, therefore, from the proteid of the meat, since fat is not present to any extent in the diet.

It is of great importance to note further that if proteids are necessary for the repair of waste in the tissues, they are equally necessary for the building up of new tissues, as in the growing person, for the production of blood, the growth of muscle, bone, nerve, &c. So that, if an adult man needs only the quantity of proteid that will repair the wear of his tissues, which is not materially increased by his work, a child needs not only sufficient to repair the daily tear and wear, but also an added quantity for growth. *The child needs, then, a larger quantity of proteid in proportion than a full-grown person.* It is because this fact is not recognized that children are fed so largely on non-nitrogenous foods, starchy foods, such as arrow-root, corn-flour, &c. They thus fail to obtain enough nitrogen for the building up of new tissues, and are white-faced from deficient blood, have soft, flabby muscles, and weak, yielding bones.

The Use of Fats.—If experiments show that work is not done at the expense of the nitrogenous tissues of the body, they equally plainly show that it is done at the expense of fats and carbo-hydrates. The waste products of the

combustion in the body of fats, starches, and sugars are carbonic acid gas and water, just as urea is the special waste product of the combustion of proteids. While the amount of urea is not increased by work, the amount of carbonic acid gas given off from the lungs is markedly increased. In the case of the watchmaker, already referred to, while the quantity of urea expelled was the same during the day of hard work as during the day of no work, the amount of carbonic acid gas expelled increased from 14,000 grains on the day of no work to 18,000 grains on the day of hard work. Moreover, if the body be in a cold atmosphere, the amount of carbonic acid given off again markedly increases, indicating an increased combustion of fats and carbo-hydrates to yield heat for the maintenance of the warmth of the body. For a similar reason fat is one of the chief articles of consumption in the Arctic regions. During starvation the fats laid down in the body are the first to disappear. It thus becomes certain that fats are consumed in the body for the purpose of yielding energy for work, and heat for maintaining bodily warmth; and they are, above all kinds of food, best fitted for such purposes. If an amount of fat is given in excess of what is required for these purposes, it is stored up in the body as fat, waiting till called for.

The Use of Carbo-hydrates (sugars, &c.).—As has been already indicated in the paragraph on Fats, the sugars and starches introduced as food undergo combustion in the body for liberating energy and heat, but they are less useful than fats for these purposes, and the explanation of that fact is given on p. 532. These kinds of food-stuffs may be stored up in the body, if not immediately needed, in the form of animal starch or glycogen, which is manufactured and stored in the liver, as explained on p. 147. Thus Dr. Pavy showed by a series of experiments, conducted on dogs, that by a diet of starch and sugar the size of the liver was greatly increased, and that the increase in size was due to the increased quantity of glycogen produced in it from the starch and sugar. It is possible that subsequently this glycogen, before being consumed in the body, undergoes a further conversion into fat. It has been certainly proved that sugars and starches become transformed into fat in the body, and, if not immediately required, are stored up as such. Thus two observers, Gilbert and Lawes, fattened pigs on a diet rich in carbo-hydrates and found that 472 parts of fat were laid down in the body for every 100 parts of fat contained in the food. The increase in the fat could have been effected only by a transformation of the starch and sugar of the food into fat. The wax of bees is a fatty substance, and Huber showed that bees produced wax when supplied with nothing but sugar. Then the delicacy known as *pâté de foie gras* is made from the fatty livers of geese. The fatty degeneration of the liver is produced by stuffing the geese with a food rich in proteids and carbo-hydrates, and preventing exercise. The fat is, therefore, manufactured in the body from that which is not fat.

Sugars and starches, then, are consumed in the body for yielding energy and heat, while any excess is converted into glycogen or fat and stored till required.

We may represent these conclusions in the following table:—

Uses of the Various Food-stuffs in the Body.

WATER	Required by all the tissues. Daily supply needed to replace what is given off from lungs, skin, and kidneys.	
SALINES or MINERAL MATTERS	Enter into the composition of all the tissues, and promote their healthy activity.	
PROTEIDS	1. Build up tissues, muscle, bone, nerve, &c., in the growing person. 2. Repair the tear and wear of the tissues, constantly occurring, irrespective of work.	Excess: 1. May be directly consumed to yield energy and heat. 2. Part may be stored up as fat till required. 3. Part may be stored up as glycogen.
FATS	Undergo combustion to yield (1) Energy for work, (2) Heat.	Excess, Stored up as fat till required.
CARBO-HYDRATES (Sugars, Starches, &c.)	Undergo combustion to yield (1) Energy for work, (2) Heat.	Excess: Stored up as (1) fat, (2) glycogen.

The practical conclusions from these considerations have been already indicated, but will bear repetition.

There is a marked difference, in the proportion of the various kinds of food-stuffs, between the diet suitable for the full-grown person and that for the growing child.

As regards the full-grown man—

1. He needs a quantity of proteids sufficient to repair tear and wear of tissues. This quantity is, broadly speaking, the same from day to day, and is not materially affected by the amount of work done.
2. He needs a quantity of fats and carbo-hydrates, increasing (1) with increased work, in order to yield an increased amount of energy, and (2) in a cold climate or in cold weather, to yield an additional quantity of heat, and decreasing with lessened work or warmer weather.

As regards the growing person—

1. He needs a quantity of proteids sufficient to repair tear and wear of tissues.
2. He needs, over and above, a quantity of proteids for purposes of growth.
3. He needs fats and carbo-hydrates according to exercise, external cold, &c.

These facts show at once the great value of milk as a diet for children, and its much less value as a diet for adults. It contains a quantity of proteids, relatively large in proportion to the fats (cream) and carbo-hydrate (sugar of milk) it contains, and thus meets the wants of growing tissues, but the adult needs a larger proportion of the fats and carbo-hydrates, for the doing of work, than it affords.

Setting water and saline materials aside as being derived from the inorganic world, the world of lifeless matter, it will help us greatly in realizing the extent of the proteids, fats, and carbo-hydrates, derived from the organic world, if we now give a list of the most commonly known food-stuffs, indicating into which of these classes they fall.

NITROGENOUS OR PROTEID FOOD-STUFFS.

From Animal Kingdom.	From Vegetable Kingdom.
Butchers' Meat of all kinds.	Beans, Peas, Lentils.
Poultry.	Wheat, Oats.
Wild-fowl.	Flour and Oatmeal.
Game.	Rye, Barley.
Fish.	Indian Corn, Rice.
Shell-fish.	Potatoes.
Eggs.	Vegetables of all kinds.
Milk.	Fruits of all kinds.

NON-NITROGENOUS OR CARBONACEOUS FOOD-STUFFS.

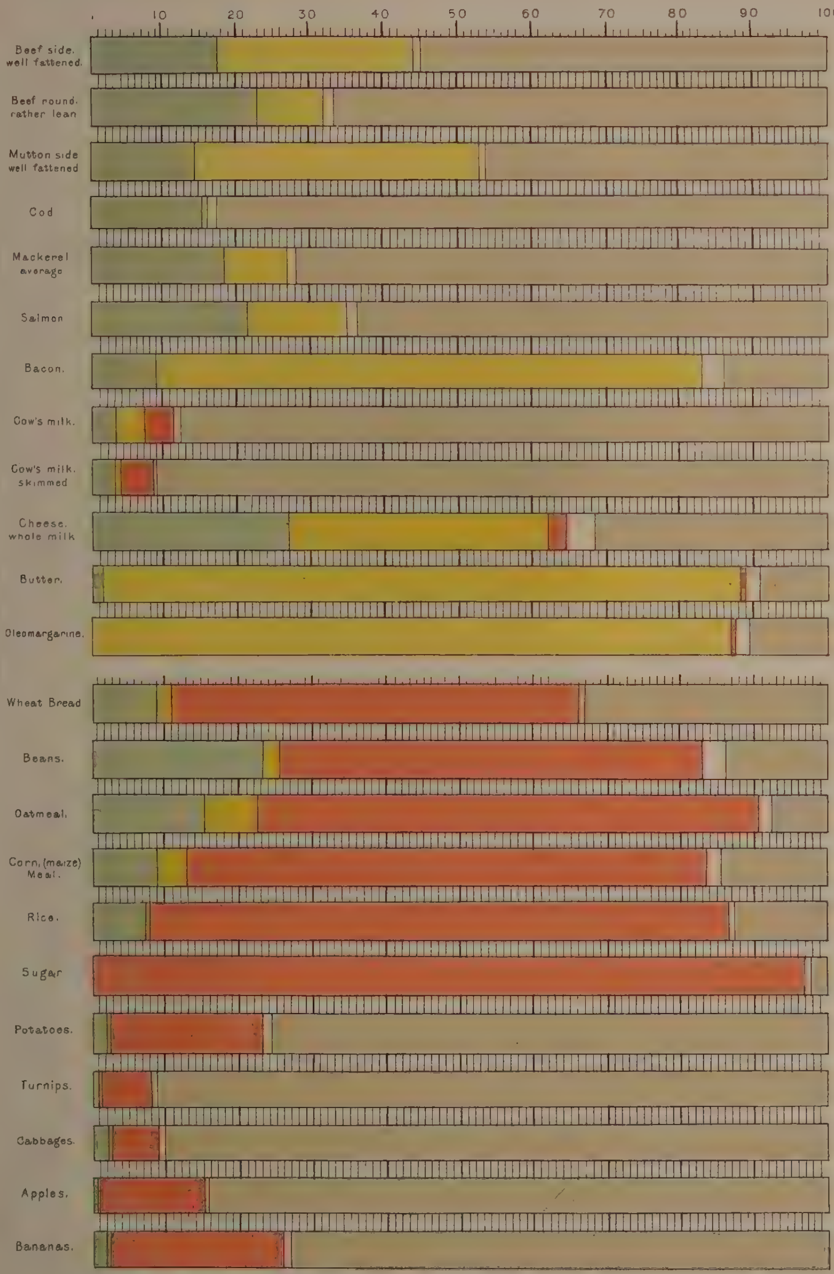
Sugars.	Starches.	Fats.
Cane-sugar.	Sago.	Butter.
Grape-sugar.	Corn-flour.	Dripping.
Beet-sugar.	Arrow-root.	Lard.
Treacle.	Tapioca.	Butterine or Oleo-Margarine.
Golden Syrup.	Cassava.	Oils, such as Olive and Almond Oil, &c.
Honey.	Tois-le-mois	
Manna.		

Gums also belong to the Non-Nitrogenous class.

With the knowledge we have thus far gained, it is possible for us to make some broad general statements. Thus we can say that a diet which consisted almost exclusively of corn-flour, arrow-root, or sago would be entirely an improper diet because of its want of nitrogen, and of its consequent utter inability to yield material for building up wasted tissues. But such general knowledge as this is of very limited value. We can say that beef is nitrogenous, and is, therefore, a food-stuff that will yield the material for repairing the waste of the body. But besides nitrogenous or proteid material, beef contains other substances, and we have as yet no information that will enable us to judge how much nitrogen one pound of beef may contain, and how much of it will be necessary for a day's ration. We have as yet no means of saying whether beef or beans supplies the nitrogen in largest amount. In order to obtain this fuller information a complete analysis of the various food-stuffs is necessary. Such complete analyses have been made. They show that any one of the nitrogenous food-stuffs named in the above table is really a mixture of two or three, sometimes of all, of the classes of food material tabulated on p. 538. Thus beef is a mixture of water, mineral matters, fat, and nitrogenous material; milk is a mixture of water, saline matters, fat, carbo-hydrate in the form of sugar, and nitrogenous matter in the form of curd; oatmeal contains water, mineral matters, carbo-hydrate in the form of starch, fat, and nitrogenous material—some, that is to say, of all the different classes of food-stuffs; and so on. This is shown in a very striking way in Plate IX., where the composition of various animal and vegetable food-stuffs is represented by variously coloured bands. Each band represents 100 parts of the food-stuff, say 100 lbs., and it is divided by small marks above it into 100 equal parts. The portion of the band marked blue represents the amount of nitrogenous material in the 100 of the food-stuff. The yellow part of the band

THE COMPOSITION OF FOODS.

Plate IX



Each band represents the composition of 00 parts of the food-stuff. The fine lines between the bands are hundredths, and the fewer and darker lines are tenths. Each band is thus provided with a scale by means of which the proportion of each ingredient can be easily read off. The scale above the first band is numberec and by carrying the eye down the plate the number can be easily made to apply to the other bands also. Thus wheat-bread is seen to consist of proteids to the extent of 9 per cent. of fat to the extent of 2 per cent. of carbo-hydrates, (sugar and starch) to the extent of 55 per cent. of mineral matters 1 per cent. and of water 33 per cent. while butter contains about 1½ per cent. proteids, 87 per cent. fat, barely 1 per cent carbo-hydrates, 2 per cent. mineral matters, and rather over 8½ per cent. water.

Explanation of Signs.

Nitrogenous, or Proteids. | Fats. | Carbo-hydrates. (Sugar & Starch) | Mineral Matters. | Water

represents the fat, the red the carbo-hydrate (which may be sugar or starch, or a mixture of both), the white portion indicates the saline, and the black the amount of water. To give a complete example. Beef, from the side, well fattened, contains 17·5 per cent proteid, nearly 27 per cent fat, something over 1 per cent mineral material, and fully 54 per cent water, no carbo-hydrate.

With such analyses as these our knowledge of food-stuffs ceases to be vague and general, and questions as to the best food for building up tissues and for liberating energy can be readily answered, while we are supplied with the means of comparing various articles of food and determining their relative value.

We shall, therefore, now proceed to go over the various articles commonly used as food, giving tables of their composition. After that we shall be able to discuss fully questions relating to diets—what quantities and kinds of food ought to be used by the average person per day, and to give details as to how a diet should vary in accordance with varying circumstances of age, sex, work, and climate, &c.

COMPOSITION OF ANIMAL FOODS.

I. Nitrogenous Animal Foods.

BUTCHERS' MEAT.

Percentage Composition of Meat.[1] (Letheby.)

	Lean Beef.	Fat Beef.	Lean Mutton	Fat Mutton	Fat Pork.	Veal.
Water, ...	72	51	72	53	39	63
Nitrogenous, .	19·3	14·8	18·3	12·4	9·8	16·5
Fat, ...	3·6	29·8	4·9	31·1	48·9	15·8
Saline,.........	5·1	4·4	4·8	3·5	2·3	4·7

An examination of the above table reveals some very interesting facts. It will be noticed, first, that the proportion of water present in meat is very much higher than would ordinarily be supposed. It varies from about 50 to about 70 per cent. That is to say, 4 lbs. of lean beef, if perfectly dried, will shrink to rather less than 1¼ lbs. The second readily observed fact is that there is a relation between the quantity of water and the quantity of fat. It will be seen that when the proportion of water is large the proportion of fat is small, and when the proportion of fat becomes large the amount of water is diminished. Thus fat beef contains 21 per cent less water than lean beef, but 26 per cent more fat. Fat, that is to say, displaces water. This is quite in keeping with the popular notion that very lean beef is not economical. At the same time an excess of fat is undesirable and wasteful; for then it cannot readily be made use of, and, as the table shows, taking equal weights of lean beef and fat beef, there is less nitrogenous material in the fat than in the lean. The fat ought not to be in large masses on the meat, but should be distributed throughout it, showing as white lines running through the beef, giving it a marbled appearance. The amount of fat laid down in an animal's body is dependent upon a variety of circumstances. The kind of feeding has a marked influence, and the mode of life affects the fattening process in a very marked way. Animals in the wild state do not fatten. Fat is not laid down in the body, because carbonaceous substances are consumed in the body for yielding the energy needed in the state of unrestrained freedom. It is estimated that of the total weight of an ox ready for the market one-third is fat, and that fat forms rather more than the same amount of the body of a sheep.

There is also a considerable difference between the flesh of young and of mature animals. As a rule, while the flesh of the young animal is more tender, it is less nutritious and less digestible. Specially is it likely to be less nourishing if the animal has been quickly fed for the market. Enough time has not been given to permit the development of the muscular fibre, which is, in consequence, flabby and insipid. On the other hand if the animal has been too old or has been used for work, the flesh is too firm and hard to make pleasant eating.

Beef is said to be at its best when cut from the carcass of a four-year-old ox, and wether mutton from a three-year-old is in the best condition.

There is an important point on which the table is silent, and on which, indeed, chemical analysis can give no information, and that is flavour. It depends upon the presence in the meat of a series of bodies, which, because they can be dissolved out by water, are called **extractives** (see p. 537). They are found in greatest abundance in the flesh of wild animals, and it is their presence in more than usual quantity that gives to meat the quality people speak of as "richness." It is because the flesh of young animals is so deficient in these bodies that it is poorer and less tasty than that of the mature animal. Flavour also varies with the animal, the flesh of each kind having its own peculiar character. It is influenced by the feeding, being best just before removal from green pasturage

[1] These analyses differ considerably from those in Plate IX. The above are analyses of English samples, those of this Plate are American.

in the months of September and October; and it is diminished by artificial feeding. It is the natural feeding and the unrestrained life that give mountain-fed mutton the quality that makes it so desired. Turnip feeding imparts a particular kind of flavour.

The analyses given in the table apply to meat without the bone, and if any calculation is made, by means of the table, of the various nutritive materials present in, say 1 lb. of beef, as bought for domestic purposes in the ordinary way, due allowance must be made for the inevitable piece of bone. It has been calculated that of a whole ox carcass bone forms from 10 to 20 per cent of the whole weight, but the amount varies according to the cut.

Thus joints seldom contain less than 8 per cent of the weight in bone.
The neck and brisket contains 10 per cent do.
The shin and legs 33 to 50 per cent do.

Thus the most economical parts are the round and the thick flank, next in order comes the brisket, and lastly the leg. In mutton and pork the leg is the most economical and then the shoulders.

Bone, however, is not an innutritious portion of the animal, provided the nutriment is properly extracted from it. Church gives an analysis of the bone of a mutton chop, showing the following ingredients:—

Water	32·2 per cent	or 5 oz.	66 gr. in 1 lb.
Nitrogenous	18·7 ,,	2 ,,	434 ,, ,,
Fat	9·0 ,,	1 ,,	193 ,, ,,
Saline (Phosphate and carbonate of lime)	40·1 ,,	6 ,,	182 ,, ,,
	100·0	16 oz.	

Smith, basing his calculation upon the analysis of shin-bones, estimated that

3 lbs. of shin-bones would yield as much carbon as 1 lb. of beef.
6 lbs. of shin-bones would yield as much nitrogen as 1 lb. do.

that is, the nutritive value of bone is as regards nitrogen $\frac{1}{6}$ that of beef, and as regards carbon $\frac{1}{3}$ that of beef. Bones vary in the amount of nutritive material they contain according to their form. Dense bone contains less animal and more mineral matter than spongy bone, and the more abundant the marrow the more useful the bone, for marrow consists largely of fat, and is therefore of value as yielding carbon for liberation of heat and energy. In order that the nutritive material may be properly extracted bones require grinding down. This could not be attempted for ordinary domestic purposes, but at any rate the bone ought to be well smashed up, to permit the extraction of as much nutriment as possible. The joint ends of bone yield, from the gristly material and from the tendinous and ligamentous parts about the joint, a substance which, on boiling, is converted into gelatine. It is this, perhaps, more than the nutritive material extracted from the bone itself, that makes the bone useful for the making of stock for soup.

Percentage Composition of Various Parts of Animals.

	Sheeps' Kidney.	Calves' Liver.	Tripe.	Foie Gras.	Bacon, fat salted and dried.
Water	78·60	72·33	67·1	22·70	13·9
Nitrogenous,	16·56	20·0	13·3	13·75	9·0
Fat	3·33	5.58	17·1	54·57	74·1
Carbo-hydrate.	0·21	0·45	—	6·40	—
Saline	1·30	1·54	2·5	2·58	3·0

The above tables show the nutritive value of the various internal organs noted. There are, however, objections to their use, mainly on account of their being difficult of digestion. Thus the kidney is of a close texture, and unless skilfully cooked, so that all the juices are retained, it may be hard and with little flavour. The same objection exists to the use of the heart, which closely resembles ordinary meat in its composition, though it is much firmer and harder. The liver is rich and savoury when properly cooked, but easily rendered hard and tasteless, and is difficult of digestion. Comparison between the table of calves' liver and foie gras, the fatty liver of Strasburg geese (see p. 541), indicates how the kind of feeding followed in the case of the geese alters the composition of the organ. The table shows the fatty liver to consist of over a half of fat. Tripe used as food consists of the paunch, or first portion of the stomach of the ox or cow. Of considerable nutritive value, it possesses the great additional advantage of being the most easily digested of animal foods, and it is of very agreeable flavour. Sweetbread is, strictly speaking, the pancreas (see p. 142), but the organ sold by butchers under this name is specially the thymus gland (p. 205), and other glands, such as the thyroid (p. 205), are also sold under the same name. The thymus of the calf is the most esteemed. It is nourishing, and when properly cooked easy of digestion. The lungs or lights are eaten along with the liver, and

though containing nutritious material are rather indigestible.

The blood of animals, chiefly the pig, is consumed in the form of black-puddings, which are made of a mixture of blood, groats, fat, and various herbs. The mixture is contained in a piece of skin from the intestine of the pig. Bacon belongs to the class of cured meats. The flitch is from the side. The process of curing consists in rubbing into the side a mixture of salt and saltpetre (nitre). Brine is also forced into the flesh by a force-pump. The sides, after being dressed in this way, are piled on one another for four days, then turned and sprinkled with salt, and allowed to lie for twelve days. After washing and drying they are hung in the smoke-house and submitted to the fumes of burning oak sawdust for three days, when they acquire the proper flavour and are ready for market. "For domestic use pork may be cured as follows: Stir some salt with hot water till no more of the substance is dissolved. This forms the brine or pickling liquor. Then mix, for a pig of moderate size, one pound of brown sugar and half a pound of nitre; rub this mixture well into the meat, which is then to be put into the pickle, remaining there two days. After this take it out and rub the pieces with salt alone. Return it to the pickle. It will be ready for use, after drying and smoking, in six or eight weeks" (Church). The small quantity of water contained in bacon makes it, weight for weight, of more nutritive value than fresh pork, while the pickling process renders the fat more digestible than it is in the fresh state. This is an exception to the general rule that curing renders meat less digestible. If the pickling has been too long continued, however, the lean portions will have become too dry by the abstraction of the juices. By noting in the above table the relative proportions of nitrogenous material and fat in liver and bacon, the meaning and advantage of combining these two in one dish becomes apparent, the one making up for the deficiencies of the other. The same is true of the combination of chicken and ham, for the flesh of fowls, as will be seen from the succeeding table, contains a very slight admixture of fat, while it is more than usually rich in nitrogenous material.

The same advantage is gained from a mixed diet of ham and eggs, veal and ham, bacon and beans, rabbit and ham, &c., the bacon or ham supplying in each case the fat, while the eggs, beans, veal, or rabbit yields in abundance the nitrogenous constituent.

POULTRY, GAME, AND WILD-FOWL.

Percentage Composition of Poultry and Game.

	Fowl.	Hare.
Water	73·15	74·35
Nitrogenous	22·65	23·34
Fat	3·11	1·13
Saline	1·09	1·18

The number of birds used as food, in various parts of the world, is very great. The analysis of the common barn-yard fowl may be taken as a fair sample. It will be noticed that the proportion of fat is small, and the proportion of nitrogenous material large, the latter existing in larger quantity even than in lean beef. Wild-fowl contain still less fat. The flesh of the white-fleshed birds is more tender, more delicate in flavour, and more easily digested than the dark-coloured flesh, for example, of ducks and geese. The latter is, however, richer and more stimulating. Game-birds are desired for their special flavour, which, by stimulating the appetite, counterbalances the disadvantage of the increased firmness and solidity of the flesh. The character of the flesh is, of course, influenced by domestication. If prevented from obtaining exercise, the birds will become fat, and it also appears that, after spaying, the animal fattens more easily, grows to a larger size, and develops a finer flavour. A *capon* is a cock-chicken which has been thus treated, a *poulard* is a spayed hen. The flavour is also markedly different in flesh-eating from that of grain-eating birds. The flesh-eating bird is of a stronger, fuller, and less agreeable flavour, and the feeding of such birds on grain greatly improves them in this respect. The keeping of game, till it is decidedly "high," is for the purpose of making the flesh more tender and easily eaten.

The breast is not always the most tender part of the bird. It is so in the common fowl and the partridge, because these birds walk rather than fly, and the wings and breast muscles are less exercised. But, in the case of the woodcock and snipe, the legs are preferred, because these birds fly most, and the wings consequently are firmer from exercise.

While there seems to be no bird whose flesh is injurious, if eaten, it yet appears that some birds may become poisonous by eating certain foods. The pheasant of North America is said to be poisonous during the winter and spring, if fed on the buds of *Calmia latifolia*, and American partridges have been found to possess poisonous properties (Pavy).

The flesh of hare and rabbit resembles that of fowl rather than that of butchers' meat. It also is characterized by the absence of fat. The flesh of the hare is particularly rich and nourishing, that of rabbit having a less defined flavour; but it is more easily digested, and, just because of its greater delicacy, is more suited for an invalid or convalescent. Hare-flesh is highly nutritious, but is rather for the healthy and vigorous than for the sick.

Venison, the flesh of the deer, resembles game rather than butchers' meat. It possesses little fat, but is rich in extractives, and therefore savoury and stimulating. It is, moreover, readily digestible. The flesh of park-deer resembles that of the domestic sheep because of restricted exercise.

Squirrels are eaten in some of the western parts of America, and by the natives of Australia, and form a favourite dish in Norway and Sweden. The flesh is said to be tender, and to resemble that of the barn-door fowl. The flesh of the opossum is compared to that of the rabbit or hare.

Edible birds' nests are esteemed great delicacies in China. The edible portion of the nest is really formed of dried saliva, and is constructed by the bird, the salangan, a kind of swift, as a support on which its nest is afterwards raised of grass, leaves, and sea-weed. The birds build in caves near the sea or inland, and it is by means of the brackets which the animal makes, that its nest is supported. It is said to require fifty such brackets to make up a pound in weight, and the best of them sell for £5 to £6 the pound. They are obtained chiefly in the islands of the Southern Archipelago.

EGGS.

Percentage Composition of Hen's Egg (Church).

	White.	Yolk.	White and Yolk Mixed.
Water	84·8	51·5	71·7
Nitrogenous	12·0	15·0	14·0
Fat	—	30·0	11·0
Extractives and membranes	2·0	2·1	2·0
Saline	1·2	1·4	1·3

The eggs of a great variety of birds are used as food, and there is no bird's egg which may not be so employed. The eggs of different birds differ much not only in size, &c., but also in flavour. The flavour is mainly determined by the feeding of the bird.

Within the shell the whole egg is inclosed in a delicate double envelope or membrane. Throughout the white of the egg run delicate strands of membrane dividing off compartments in which the semi-liquid white is inclosed. Within the white, inclosed also in a delicate membrane, is the yellow yolk attached to the membranes of the white by two fine cords or chalazæ, one towards each end of the egg, which suspend the yolk and permit it to move readily within the white. It is on the yolk and from a part of it that the young bird is developed. The part is indicated in the fresh egg by a small white area, called the cicatricula, about the sixth of an inch in diameter, which is always uppermost in whatever position the egg is placed. The rotation of the yolk on its chalazæ achieves this. While only a part of the yolk developes into the young bird, the remainder and the whole of the white serves to nourish it till it is ready to break out of the shell. So that within the egg itself is contained all the material necessary for the development of the tissues and growth of the chicken during a considerable period of its existence.

The shell is usually about the $\frac{1}{10}$th of the total weight of the egg, the yolk weighs $\frac{3}{10}$ths, and the white $\frac{6}{10}$ths.

The shell consists of 3 per cent organic matter, and 97 per cent inorganic salts, of which 91 per cent is carbonate of lime, and the remaining 6 per cent is phosphate of lime. It is porous, and thus permits exchanges to go on between the air outside and the contents of the shell. It is because of the entrance, through the shell, of putrefactive germs in the air that decomposition is set up, and the egg becomes bad. This may be prevented by rubbing newly-laid eggs over with fat or butter, which enters the pores and seals the egg, as it were, against the entrance of air. Eggs have been kept fresh for two years, and may easily be kept, it is said, by covering them with a solution of one-third bees'-wax and two-thirds olive-oil. They may be kept for a considerable time also by packing them, small end downwards, in clean dry salt. They may be preserved also in strong solution of salt or in lime-water. Bad eggs swim even in pure water because of their loss of weight owing to decomposition, and the quantity of gas the decay has produced. Good eggs should sink in a solution composed of 1 ounce of salt in 10 ounces ($\frac{1}{2}$ pint) water, and in the same solution indifferent eggs float. The white and yolk of eggs differ very much in their composition, as the tables show. The white is almost entirely a weak solution of albumin in water, for the nitrogenous constituent is pure albumin (see

p. 536), and the water exists to the extent of nearly 85 per cent. So that of the white of egg only $\frac{1}{8}$th part consists of really nourishing material, namely, the albumin. Though in solution in cold water, it becomes coagulated into a white clot when heat is applied, and the albumin in this coagulated condition will no longer dissolve in water. When the composition of the yolk is examined, a marked difference is observed. There is 33 per cent less water, and 30 per cent fat, besides 3 per cent more albuminous or nitrogenous material. The fat may be extracted as a bright yellow oil by means of alcohol or ether. The yolk is much richer then, and more nourishing than the white. Yet the white forms $\frac{6}{10}$ths of the whole egg, so that when the mixed white and yolk are taken, the rich yolk is diluted, as it were, by the weak white, as will be seen on referring to the table. It is sufficiently plain from these tables that eggs are not the concentrated food most people imagine. As a matter of fact an egg scarcely contains more nourishing material than a piece of beef of equal weight. This is proved in more detail on p. 555. A man, restricting himself to eggs alone, could not obtain sufficient waste-repairing and energy-yielding material out of less than eighteen eggs per day.

The inorganic salts of the egg are those of phosphorus, iron, lime, soda, potash, and magnesia.

The weight of the hen's egg is from 1½ to 2 ounces; a duck's egg weighs 2 to 3 ounces, a turkey's 3 to 4 ounces, and that of a goose 4 to 6 ounces. A duck's egg contains a fourth more nourishing material than a hen's egg.

FISH AND SHELL-FISH.

Percentage Composition of White Fish.

	Whiting.	Cod.	Haddock.	Sole.	Skate.
Water........	83·0	77·5	78·0	86·1	73·79
Nitrogenous	15·1	18·5	18·1	12·0	24·03
Fat...........	0·8	3·0	2·9	0·7	0·47
Saline........	1·1	1·0	1·0	1·2	1·71

Percentage Composition of Fat Fish.

	Herring.	Mackerel.	Eel.	Salmon.
Water...........	80·71	68·27	79·91	74·45
Nitrogenous....	10·11	23·42	13·57	18·75
Fat...............	7·11	6·76	5·41	6·22
Saline	2·07	1·55	1·11	0·58

In the above tables a rough distinction has been made between two classes of fish, depending on their chemical composition. To the class of lean fish, that is, with comparatively little fat in their composition, belong the fish with more or less white flesh. The commoner examples of this class are given in the table, and to the same class, with a chemical composition of which that of the haddock may be taken as an average, belong turbot, brill, plaice, whitebait, smelt, flounder, hake, ling, gudgeon, and pike. The class to which herring, salmon, &c., belong is characterized by a considerable increase in the quantity of fat, and has usually flesh more or less coloured. The sprat, pilchard, and lamprey belong to the same class. According to the table the herring is richest in fat; but the eel is usually represented as one of the fattest of fish, Letheby's analysis crediting it with nearly 14 per cent of fat, and Payen stating the percentage of fat in the eel, when the non-edible parts have been removed, as nearly 24. It may be remarked here that there are considerable variations in the analyses of different food-stuffs, as given by different authorities, depending upon the state of the particular samples from which the analyses were made. Thus in fish the composition varies with the season, the animal being at its highest state of perfection previous to spawning, when it is fatter, and the flesh has a richer flavour. After spawning the animal is much leaner and the flesh is more watery. It is estimated that during the spawning period as much as 17 per cent of the total fat present in the body may disappear.

In the case of the salmon, herring, mackerel, eel, &c., the fat exists among the muscular substance, and there is also a layer of fat beneath the skin, specially beneath the skin of the belly, whereas, in the cod, skate, &c., the fat is present in greatest amount in the liver, which is, in the season, gorged with oil.

Fish compares favourably with butchers' meat, containing a nearly equal amount of nourishing material, weight for weight, as beef. The extractives, to which butchers' meat owes its richness and fulness of flavour as well as its stimulating properties, are present in less quantity, however. Fish is thus less satisfying and stimulating than beef, and is, on that account, not so extensively used as it ought to be. Because of this, however, its nutritive value is not actually impaired, while these qualities make it of much value to persons of weak digestion and to persons of sedentary habits. Its deficiency, specially the deficiency of white-fish, in fat is easily made up by mixing the diet with fatty substances. Butter sauces, for example, make up for this. Fishing populations

have learned this by experience. Thus the people of Cornwall and Devonshire make a fish-pie of fish mixed with thick pieces of fat pork, salted and peppered,and covered by a good crust. They thus obtain all the requisites of a nourishing meal; and the healthy condition of the people shows how satisfactory is thé diet. "In no other class than in that of fishers do we see larger families, handsomer women, or more robust and active men" (Dr. Davy). The value of fish from an economic point of view, as compared with butchers' meat, is discussed on p. 555.

The flavour of fish varies with their feeding, the special character of the feeding-ground being the cause of the peculiar excellence of Loch Fyne herring, Dublin Bay haddock, Dogger Bank cod, and Tay salmon. The whiting is the most delicate and tender, and near it is the haddock; the sole, flounder, turbot, cod, hake, and ling follow. The white-fish are the most digestible; and diminished digestibility accompanies increased firmness of flesh. This is seen in cod-fish, which in season is firm, and becomes opaque on boiling, showing curdy material between the flakes. But this very firmness, desirable as indicating seasonableness, is a disadvantage from the point of view of digestion. The firmness of the cod is increased by crimping, which consists in making cross-cuts into the flesh immediately after the fish is killed, and then plunging it into cold water. This is supposed to improve the flavour. The flavour of some fish, such as trout and salmon, is best when they are cooked and eaten speedily after being killed; but others, such as turbot, improve with keeping. The fat fishes are the least digestible of all.

Roe and milt are parts of the reproductive organs, the former, which is the hard roe, belonging to the female, and the latter, the soft roe, to the male. Caviare is the preserved hard roe of the sturgeon.

Many substances of great commercial value are made from various parts of fish. Thus isinglass is derived from the swimming-bladder, specially of the sturgeon. Glue is made from refuse of fish; and so on. The Normal Company, of Aberdeen, has shown that every part of the fish can be utilized, and that the parts of the fish regularly discarded as useless, when properly made use of, represent an enormous money value.

Fish sometimes possess poisonous properties, possibly because of some kind of feeding. Such poisonous fish are met with in the tropics. There are some people injuriously affected by fish at any time, even as others cannot eat mutton or eggs without great disturbance.

There does not seem any scientific ground for the popular notion that fish is a specially useful food for brain workers. It was thought that fish were rich in phosphorus, which enters into the composition of brain tissue, and were, therefore, specially useful. This idea arose from the glow given out by fish in the dark. But such phosphorescence is probably due to a minute organism, and is a thing apart from the chemical composition of the fish.

Percentage Composition of Shell-Fish.

	Lobster.	Oysters.	Mussels.
Water,	76·62	80·38	75·74
Nitrogenous,	19·17	14·01	11·72
Non-nitrogenous and loss,	1·22	1·40	7·39
Fat,	1·17	1·52	2·42
Saline,	1·82	2·69	2·73

The above may be taken as fairly representative of the shell-fish class. They contain a fair quantity of nourishing material. In the case of lobster, crab, crayfish, &c., there are serious objections to their use. They are among the most indigestible kinds of animal food. They are coarse feeders, and this may account for the disturbing effects they so readily produce, apart altogether from any difficulty of digestion. Under any circumstances, however, they excite even serious irritation of stomach and bowels in some persons, producing cramp, colic, purging, and violent symptoms of irritant poisoning; while in others the partaking of even a small amount of shell-fish (and specially mussels) to supper would induce a skin eruption like nettle-rash. Oysters are not so open to this objection; indeed they are frequently found pleasant and appetizing by persons of weak digestion and convalescents. The flesh of the claws of lobsters and crabs is more delicate and digestible than the soft internal parts, which are mainly liver. The mass of little round black bodies, found beneath the tail of the female lobster, is the spawn, and is used for sauce. The beard of the oyster is formed of the gills, and is frequently removed; the large hard portion of the interior, which is a muscular part, ought also to be rejected, as it is the least digestible part. The addition of vinegar, spices, &c., to shell-fish is, as a rule, an aid to their digestion, as these substances act as stimulants to the stomach and promote the flow of the digestive juices. Oysters are more easily digested when raw than when cooked. They are in season only when there is an "r" in the name of the month.

TURTLE.

Both the fresh-water and marine turtle are consumed as food. The former abounds in certain districts of the Continent, and is used by the inhabitants. The *terrapin*, a fresh-water turtle, is imported into this country from America. Land tortoises are also found wholesome and agreeable food by the natives in India and Africa and by the North American Indians.

The edible or green turtle (*Chelonia mydas*) is the one chiefly used in this country. It is from 6 to 7 feet long, and sometimes weighs 700 pounds. They are imported alive; and the flesh cut up into pieces and sun-dried is also imported in large quantity from the West Indian islands. The flesh is sometimes used as steak, but is principally employed for soup. For this purpose the shields covering back and belly are removed from the animal, scalded to allow of the removal of the scales, and boiled. The soft, glutinous parts are then removed from the hard bony portion and cut up into small oblong pieces. It is these pieces that are prized, and are erroneously called green fat. The liquor is used as stock for soup. The shield from the back is called callipash (the carapace of naturalists) and that from the belly callipee—names well known to cooks, epicures, and aldermen. "The callipee, or underpart of the breast or belly, baked, is reckoned the best piece." It is white, like veal or chicken, after being boiled. The meat from the callipash is dark-coloured, and is sometimes called black or green meat. The fat of the turtle is greenish-yellow in colour, and it also is used for soup. It is said to colour the urine and sweat of those who eat of it. Turtle is said to be highly nutritious, and when plainly cooked easy of digestion—tender, delicate food when young, but more tough and gristly as it grows old. "The juices are generally reckoned great restoratives."

The eggs of the turtle are also used as food. They are deposited in great numbers in the sand of the bays and lagoons, to which the turtle resorts for that purpose several times a-year. They are hatched lying in the warm sand, and the difficulty is to procure them in a perfectly fresh state.

The flesh of the turtle is about 75 per cent water, and of the remaining 25 per cent about one-half is fat, the rest being flesh.

Mock-turtle soup is made with pieces of the gelatinous portions of the scalp of the calf's head, which resemble to some extent the glutinous pieces of turtle.

MILK.

Average Percentage Composition of Human Milk and Milk of Different Animals.

	Human	Cow.	Ass.	Goat.	Mare.	Sheep.
Water, ...	88·0	86·87	91·17	87·54	88·80	82·27
Nitrogenous,.	2·97	4·65	1·79	3·62	2·61	7·10
Fat (Butter),.	2·90	3·50	1·02	4·20	2·50	5·30
Sugar,..........	5·97	4·28	5·60	4·08	5·59	4·33
Saline,..........	0·16	0·70	0·42	0·56	0·50	1·00

Milk is an emulsion. It consists, when seen under the microscope, of a multitude of exceedingly fine globules of oil, each globule being surrounded by an albuminous film, which keeps the globules from running together, the globules floating in an opaque fluid. The fluid contains albuminous bodies, milk-sugar, and salts, in solution. When perfectly fresh it is slightly alkaline in reaction, but it soon becomes somewhat acid.

When milk is allowed to stand the oil-globules, being light, rise to the surface and form the layer of cream, so that the cream is mainly the fatty portion of the milk, the globules in it being still separated from one another by the albuminous envelopes. When milk is churned, the albuminous envelopes are ruptured, and the released globules of oil run together, forming little masses of fat. These masses are collected, as much of the liquid squeezed out as possible, and thus the butter is obtained. If a small quantity of acid, say common vinegar, be added to milk and the milk be slightly warmed, it separates into curd and whey. The same thing occurs if the milk is allowed to stand till it becomes sour. The souring is due to the formation in the milk of an acid—lactic acid. The lactic acid is produced by a species of fermentation from the sugar present in solution in the milk. The agent in exciting this fermentation is a minute organism (see p. 389) deposited in the milk from the air. If milk be heated, and corked in a bottle when hot, it will not turn sour, because the heating has destroyed the organism; and no lactic acid being produced, curdling will not occur. But if the cork be removed and the air have access to the milk again, fresh organisms are deposited and curdling will soon take place. The explanation of curdling is this: the chief nitrogenous or albuminous body in milk is called casein. Casein belongs to the same type of substances as white of egg. We all know that white of egg will dissolve in cold water, but as soon as the water is heated to the boiling point it separates or is precipitated as a white curdy mass. Now while

casein of milk is akin to white of egg, unlike it, it does not precipitate on boiling, so long as the solution, in which it is present, is not acid but alkaline. As soon as the solution becomes acid, either by the addition of a little vinegar, or by the process of souring, the casein tends to become precipitated as curd, and will be all the more quickly precipitated if the solution is heated. So long as milk is kept alkaline, then, it will not curdle, because casein is soluble in an alkaline solution, and is therefore called alkali albuminate. The addition, therefore, to milk of a little common baking-soda (carbonate of soda) will prevent curdling taking place. Milk is also separated into curd and whey by mixing it with rennet. Rennet is prepared from the stomach of the calf, and contains a special ferment, which causes the precipitation of the casein. In the process of the digestion of milk in the stomach curdling is the first step, being caused by the acidity of the gastric juice, as well as by the presence in the juice of a curdling ferment. If a person vomits some time after a drink of milk, the milk is returned in a curdled condition, because the process of digestion has begun.

The curd of milk thus consists of an albuminous body casein, and entangled in the curd is the most of the milk-fat. The whey also contains some of the fat globules, and is, therefore, somewhat opaque. It contains also a small quantity of albumin of exactly the same character as white of egg, and it contains in solution the sugar, salts, &c., which can be readily separated out. If the whey be gradually evaporated the milk-sugar will crystallize out.

Milk, then, is really a very complex substance, and it contains a proportion of all the different kinds of material needed as food—nitrogenous, fatty, sugary, saline.

We must now look at its composition a little more in detail. It will be observed from the table that the composition of milk varies very much in different animals, that of the ass containing a total of only 8·83 parts of solid material in 100, while that of the sheep contains double the amount of nourishing material, namely 17·73 parts in the 100; and while

human milk contains 12 parts of solids in 100,
cow's milk „ 13·13 „ „

Solids in One Pint of Milk.

Nitrogenous, ...	369 grains.
Butter, ...	351 „
Sugar, ...	468 „
Saline, ...	72 „
Total Solids, ...	1260 grains.
Or fully	2·8 ounces.
Water, ...	17·9 „

Of one pint of cow's milk (20 ounces) 17½ ounces in round numbers are water, and 2½ ounces solid nutriment. If a grown person, therefore, were to live on milk entirely, a very large quantity would be necessary—between 9 and 10 pints daily at least. This would be an expensive diet. It is one, moreover, not suited as an exclusive diet for an adult, while eminently suited for a young growing person (see p. 542).

The nitrogenous ingredients in milk are principally the two already named—egg-albumin and alkali albuminate or casein, the casein being in largest proportion, forming nearly 4 of the 4·65 per cent.

Milk-fat or butter or cream is that which gives the quality and richness to the milk. It is by the amount of cream present that the quality of the milk is commonly estimated.

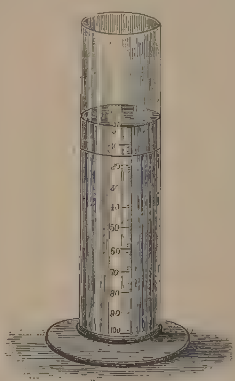


Fig. 192.—Creamometer.

There is a simple instrument, called a creamometer, which might readily be employed in households for determining the richness of milk. It consists of a test-tube (fig. 192) 11 inches long and ½ inch in diameter, which is divided into 100 degrees by a scale. The milk to be tested is well shaken to mix the cream uniformly and then the test-tube is filled with it up to the mark 0. The tube is allowed to stand upright for 24 hours, and the depth of the layer of cream on the top read off at the end of that time. Good sweet milk should give a layer of cream not less than 11½ degrees. This is, however, not a very reliable gauge, because the amount of cream which rises depends on many conditions. More cream will rise if the temperature is low, if the vessel which contains the milk is wide, and if the vessel is kept perfectly free from agitation. Another method of determining the quality of milk, which gives results varying according to whether the cream has been removed or not, is the method by taking the specific gravity of the milk. A hydrometer is used, such as is shown in fig. 193, which should sink in pure water to the level of the mark 0, which stands for 1000. In pure sweet milk it should rise to a level between 29 and 33 (1029 and 1033). That is to say, the specific

gravity of pure milk varies between 1029 and 1033. Now such milk contains say about 12 per cent of cream, and if from a sample of pure milk any quantity of cream has been skimmed, the reading from the hydrometer will be considerably different. Cream, consisting as it does mainly of fat, is lighter than water. If, therefore, a large quantity of cream be present in a sample of milk, its specific gravity will be lowered; and if the cream be skimmed off, the specific gravity of the milk will be raised. Thus pure milk with all its cream, which gives a specific gravity of between 1029 and 1033, will, if the cream be removed, give a specific gravity of between 1033 and 1037. If we take these two levels as the standards of pure sweet milk and pure skimmed milk, it is plain that the addition of water to either will cause a lowering of the specific gravity. A table has been constructed, showing the fall for varying quantities of water, and thus, by using the hydrometer, with this table a rough estimate of adulteration of the milk with water might be made.

Fig. 193. Hydrometer.

Table Showing Specific Gravity of Milk before and after Removal of Cream with Different Quantities of Added Water.

Specific Gravity before Removal of Cream.	Specific Gravity after Removal of Cream.	
1029 to 1033	1034 to 1037	Indicates Pure Milk.
1026 ,, 1029	1029 ,, 1034	= 10 p.c. added water.
1023 ,, 1026	1026 ,, 1029	,, 20 ,, ,,
1020 ,, 1023	1023 ,, 1026	,, 30 ,, ,,
1017 ,, 1020	1020 ,, 1023	,, 40 ,, ,,
1014 ,, 1017	1016 ,, 1020	,, 50 ,, ,,

Hydrometers are graduated for use with milk only, and are then termed **lactometers.** Different makers graduate the lactometers in different ways. Thus one is made graduated from 100, low down on the stem, to 0 at the top of the stem. In pure water it would sink to 0, in pure milk the stem would stand out above the milk to the level 100. If it sank so that the stem stood out to the level 90 only, that would indicate that, in 100 parts, only 90 were pure milk and 10 were added water, and so on. The graduation might begin low down at 0, at which level the lactometer should stand in pure milk, and from that point up the stem the marks would indicate percentages of added water. Thus if the instrument sank to 5, that would mean 5 per cent added water. If this method of testing the quality of milk were used, and it would be of easy domestic application, it should be employed in conjunction with the creamometer, else mistakes would arise. Take an example: a fraudulent milkman might remove a portion of cream from his milk, and in consequence the specific gravity would rise, say to 1034, indicating skimmed milk. He might then bring the specific gravity back to what it ought to be for pure milk by adding water. Of course the milk would look thin, but still the specific-gravity test alone would not indicate anything wrong. If, however, the creamometer test were applied, and a marked deficiency in cream shown, the explanation would be evident. For purposes of such testing the milk should be well mixed before the sample is poured out.

The sugar of milk or lactose contains the same proportions of carbon, hydrogen and oxygen as cane-sugar, but is of feebler sweetening power, and does not readily undergo the alcoholic fermentation, but is prone to the lactic acid fermentation, which, as already stated, is the cause of the souring of milk.

The **saline constituents** consist of salts of soda, potash, lime, magnesia; oxide of iron, and compounds of phosphorus and chlorine are also present. Milk also contains fluorine, which is an ingredient in teeth. Of the total mineral constituents phosphoric acid forms no less than about 28·5 per cent.

The composition of milk varies much with the feeding of the animal. If an abundance of suitable food be allowed to the cow, and exercise be denied, the yield is increased, and the quantity of solids in the milk is also increased. Stall-fed cattle yield more butter, because less fat is consumed in the body for yielding energy for exercise and the maintenance of temperature.

The flavour of the milk is also influenced by the feeding, the finest being yielded by feeding on fresh country pasture. Turnips and fragrant grasses impart an odour to the milk. Milk also may be coloured by food eaten, and may acquire poisonous properties, without the animal being affected, by the cow, goat, &c., feeding on certain plants. This is noticed in Malta and some districts of North America.

The milk of a cow varies also at different times of the day, and the milk obtained at one milking is not all of the same richness. The afternoon milk is said to be twice as rich in butter as the morning milk. If, as a cow is being milked, the milk is divided into several portions as it comes from the udder, the milk that came first is found to vary very much from

that yielded by the stripping of the udder. The chief difference is in the quantity of butter, the first milk, or as it is called the "fore" milk, being very poor in fat, while the last milk, or the "strippings," is rich in fat. Any one, therefore, who wishes to see a fair sample of milk yielded by a particular cow should see the cow completely milked. The whole milk should be collected in one vessel, and a sample of that taken. The cause of the difference is found in the lightness of the cream, which makes it rise to the highest part of the gland.

The average quantity of milk yielded by the cow varies with the breed. The Yorkshire shorthorn, the favourite of London dairymen, is estimated to yield on a yearly average nearly a gallon and three quarters per day (strictly 1·7 gallons per day). A good average yield is said to be 15 pints per day, but, as already stated, it varies with the feeding, exercise, &c., not to speak of the condition of the animal. The udder of the cow is estimated to be able to contain about 5 pints of milk at one time.

As an agent in the communication of disease milk must not be ignored. It is perfectly certain that milk is continually the agent in spreading typhoid fever. Probably, indeed with certainty, this arises from water tainted with excretions from a patient suffering from typhoid fever, gaining access to the milk. A very common story is that some farm hand takes ill with what is called a feverish cold or gastric fever, and is ill for some weeks. The discharges are, without any precaution, cast on the dung-heap, and fluid from it finds its way into the burn or well, from which the household obtains water. This water is used to wash the milk-vessels, not to say to add to the milk, and is then conveyed to a neighbouring town or village. Germs from the patient have thus gained entrance to the milk, where they multiply, and if the milk be used unboiled, it may convey the disease to whomsoever partakes of it. In recent years it has also become almost certain that the milk of a diseased cow may occasion disease in persons partaking of it. An outbreak of scarlet fever in Hendon, in England, and another in Glasgow, were almost conclusively traced to the use of milk, yielded by cows suffering from a febrile disease, and it has become highly probable that the scarlet fever of the human subject has its counterpart in the cow, and that it may pass from the cow to the human being by the medium of the milk. Another disease that numerous investigations have shown to be probably communicable from the cow to man by the medium of milk is tubercle, the chief if not only cause of consumption of the lungs (see p. 277). It is becoming more and more certain that specifically tainted milk is constantly sold in large towns, and the question for each one to ask is, how protection against it is to be secured. It has been shown that milk containing infection may evidence to chemical analysis no change whatever, and there is really no test of quality, taste, flavour, &c., which is of any value on this question. If the milk consumer wishes any guarantee of protection, the only one of real use he can himself supply *by bringing to the boiling point, and keeping boiling for one or two minutes, every drop of milk that enters his house,* the vessel into which it is poured from the pot being previously scalded. That is to say, to be thorough, the milk is not to be poured from the pot back into the vessel, which held it at first, unless every particle of unboiled milk has been removed from the vessel by boiling water. **Human milk** varies with feeding, &c., much as cow's milk does, and is altered by disease. Medicines administered to a nursing mother may affect the child, and, therefore, caution in giving such drugs, as mercury, opium, laudanum, &c., to a nurse is necessary. Human milk, as shown by the table, contains less nitrogenous and fatty material than cow's milk and more water and sugar. To bring cow's milk more nearly to the composition of human milk, the addition of water and sugar is necessary. The following quantities are advised:—

20 ounces (1 imperial pint) cow's milk,
10 ounces (½ ,, ,,) boiling water,
1½ ounces sugar (preferably milk-sugar),
Mix.

It is said that cow's milk coagulates in larger curds than human milk, and that this accounts for the greater difficulty infants experience in digesting cow's milk. This is remedied by boiling, which causes curdling to occur in more flaky masses.

Percentage Composition of Cream, Skim-milk, Butter-milk.

	Cream.	Skim-milk	Butter-milk.	Devonshire Clotted Cream.
Water,	55	89	90·62	28·68
Nitrogenous,	6	4·3	3·78	4·05
Butter,	36·3	0·4	1·25	65·01
Sugar,	2·5	5·5	3·70	1·77
Saline,	0.2	0·8	0·65	0·49

Cream.—The composition of cream varies very considerably, the quantity of fat varying as much as between 12 and 50 per cent, and

the water in like proportion. Much depends upon the method employed for the removal of the cream, centrifugal machines performing the process more completely than the old method.

Skim-milk varies in composition for the same reason, but the percentage of sugar is always higher than in uncreamed milk.

Devonshire Cream is of a pasty consistence. It is obtained by keeping the milk in large pans at a moderate heat for a prolonged period, and removing the scum that rises to the surface.

Butter-milk, though it is what is left of the milk after removal of the butter by churning, yet contains a quantity of butter in minute particles. Owing to the souring which has taken place, however, much of the sugar is converted into lactic acid, though it is stated in the table as sugar, and the longer it stands the more complete does this conversion become. It is rich in nitrogen, and with other food is a valuable article of diet.

Percentage Composition of Condensed Milk.

	Anglo-Swiss Coy.'s, made in Switzerland.	Made in England.	American (no Cane-sugar added).
Water,	24·13	24·99	48·59
Nitrogenous,	13·67	10·02	17·81
Butter,	8·67	10·88	15·67
Milk-sugar,	10·82	11·92	15·40
Saline,	2·23	1·96	2·53
Added Cane-sugar	40·48	40·23	———

Condensed Milk.—The above analyses give a fair idea of the average composition of condensed milk. The usual method of preparation is to evaporate the milk in vacuum-pan and then to heat to the boiling point, cane-sugar being added. The milk is then preserved in tightly-soldered tins, so that air has no access. In other cases the milk is concentrated, no cane-sugar being added, so that the simple milk deprived of most of its water is obtained. Of the former kind two analyses are given, showing fully 40 per cent added cane-sugar. This makes such milk exceedingly sweet and unpleasant to many people, though the presence of the sugar enables the milk to keep for a considerable time after the tin has been opened. Of the unsweetened kind one analysis is given. It keeps for a much shorter time after the tin has been opened. On the other hand, it will be observed that this latter kind contains, weight for weight, much more actual milk solids than the former. Thus the unsweetened contains, in 100 parts, 51·41 parts of the actual solids of milk, curd, butter, milk-sugar, and salts, while the sweetened variety contains, in 100 parts, only 35·39 of actual milk solids, though the total solids in 100 parts are brought up to 75·87 by the added cane-sugar. To put it in another way, by the lowest estimate good milk contains not less than 9 parts in 100 of solids, not counting butter. If, therefore, the total solids, excluding butter, present in a sample of condensed milk, be divided by 9, the figure obtained will indicate the amount of condensation to which the milk has been subjected, and, therefore, the original quantity of milk represented by the condensed sample. Thus, in the third analysis given above the total solids, excluding butter, are—

Nitrogenous, ...	17·81
Milk-sugar, ...	15·40
Saline, ...	2·53
	35·74

which, divided by 9, gives 3·97,

as nearly as possible 4. That is to say, the milk has been concentrated 4 times, or the 100 parts condensed milk represent 400 parts of the original milk. If one table-spoonful of this condensed milk be made up to four table-spoonfuls with water, one has restored the degree of strength of the original.

Now take the first sample, it contains of solids, not including butter,

Nitrogenous, ...	13·67
Milk-sugar, ...	10·82
Saline, ...	2·23
	26·72

which, divided by 9, gives 2·97, say 3.

This milk has been concentrated only 3 times; 100 parts represent only 300 of the original, and one table-spoonful would stand bringing up to only 3 with water to restore the original strength. Of course it has, in addition, cane-sugar, but when one buys condensed milk it is not cane-sugar one pays for, and when one feeds an infant on condensed milk it is not syrup one wishes to give.

The use of the simple rule given above will enable consumers of condensed milk to measure exactly what they are doing. When they buy the tin of milk, if its composition is not stated on the tin, let them ask for a note of its composition. The dealer who supplies it will also be able to obtain this for them. With the table of composition before them, let them sum up the total of the percentages of "solids not fat," that is, the totals of the nitrogenous or albuminoids, the milk-sugar (not the cane-sugar), and the saline, and divide the total by 9. They will thus know how much to bring the condensed up to with water to get the composition of pure

milk, and if it is for an infant it can then be further diluted according to the age of the child.

Percentage Composition of Koumiss.

Water,	87·87
Nitrogenous,	2·83
Milk-sugar,	3·76
Lactic Acid,	1·06
Butter,	·94
Alcohol,	1·59
Carbonic Acid,	·88
Saline,	1·07

Koumiss is obtained from milk by fermentation. It is specially a drink of the Tartars, and is prepared by them from the milk of the mare. Camel's milk is used for its production by the Arabs. Other kinds of milk may also be employed. Cows' milk sweetened is used in London. The actual composition of the koumiss in each case will depend upon the milk used. The Tartars add 10 parts of fresh warm milk, in which a little sugar is dissolved, to one part of milk already soured by standing. Fermentation proceeds, by which the sugar is converted partly into lactic acid, and alcohol and carbonic acid are produced. Its use is largely extending. It is nutritious, easily digested, and has some slight stimulating property on account of the alcohol contained in it. Fashion has perhaps as much to do with its employment in cases of disease as any actual benefit derived from it. It is specially extolled in the treatment of consumption.

CHEESE.

Percentage Composition of Soft Cheese.

	Camembert.	Neufchatel, fresh.	Roquefort.	Brie.
Water	51·94	37·87	34·5	51·87
Nitrogenous	18·90	17·43	26·5	18·30
Fat	21·05	41·30	30·0	24·83
Sugar	3·40	—	4·0	—
Salts	4·71	3·40	5·0	5·0

Percentage Composition of Hard Cheese.

	Cheddar.	Dunlop.	Gloucester, single.	Gloucester, double.	Stilton, fresh.	Gorgonzola.	Gruyère.	Parmesan.	Skim-milk.	American.
Water	27·83	38·46	21·41	34·3	32·18	43·56	34·68	27·56	48·02	30·13
Nitrogenous	44·47	25·87	49·12	29·2	24·31	24·17	31·41	44·08	32·65	33·81
Fat	24·04	31·86	25·38	29·6	37·36	27·95	28·93	15·95	8·41	32·88
Sugar	—	—	—	2·0	2·22	—	1·13	6·69	6·80	—
Saline	3·66	3·81	4·09	4·9	3·93	4·32	3·85	5·72	4·12	3·18

Cheese is chiefly the curd of milk, containing also a proportion of fat, entangled in the curd, varying in quantity according to the quantity of fat present in the milk from which the cheese is made, and a small quantity of the saline constituents of the milk. A small quantity of milk-sugar is present, chiefly in soft cheeses, but it undergoes alteration in process of ripening.

Fresh milk is warmed to a temperature of 80° F., and then rennet, made from the calf's stomach, is added to it along with a proportion of colouring matter, usually annatto.[1] It is allowed to stand for an hour, by which time the curd has formed. The curd is then cut up into small pieces and the whey poured off. Some of the whey is heated and poured over the curd to scald it. The curd is then removed, put into a vat, and placed under a press to expel the whey. The curd is thereafter broken up again and mixed with salt, two pounds of salt to the hundredweight of curd. The cheese is then pressed in a mould. It is then bandaged with cloths, removed from the mould, placed aside, and turned daily for five or seven days. It is then removed to the shelf of a room, kept at a temperature of 75°. It is daily turned, greased and polished, and after three or four months is ready for use. Large factories, fitted with all sorts of mechanical contrivances for carrying on the process of cheese-making, now exist, especially in America, and the cheeses they produce are of a more uniform quality. While rennet is usually employed, acid—vinegar—and other agents for curdling, may be made use of, and cheese may be made from sour milk without the addition of any such agent, the natural production of lactic acid causing coagulation.

The richness of the cheese in fat depends upon the milk used. Whole-milk cheese is made from the fresh milk, without skimming; and examples of this kind are Cheddar, Dunlop, and American. When whole-milk is used with the addition of some cream—the whole-milk of the morning and the cream of the previous evening's milking—a richer cheese is produced such as Stilton. Single Gloucester is made from a mixture of the entire milk of the morning

[1] Annatto is a dye obtained from the pulp, with embedded seeds, of a small South American tree, *Bixa Orellana*. It is very commonly adulterated with turmeric, red earths, red-lead, copper, and other substances. Its use is not to be commended.

and the skimmed milk of the previous evening; double Gloucester is made from entire milk. Neufchatel, Camembert, and Fromage de Brie are cream-cheeses. Roquefort is made from the milk of the ewe, and is kept at a uniformly low temperature during the ripening process, for which purpose the cheeses are kept in subterranean cellars. Skim-milk cheese is poor in fat. Dutch and Parmesan are examples. If the milk has been skimmed twice a very poor cheese is obtained. There is a very hard kind of cheese produced in Suffolk from milk skimmed several times, concerning which it is said that it often requires an axe to cut it, "that pigs grunt at it, dogs bark at it, but neither of them dare bite it."

From 9½ to 10 pounds of milk are required to make 1 pound of whole-milk cheese—that is to say, about a gallon of milk yields 1 lb. cheese. One cow will yield from 3½ to 4 cwt. of cheese per annum.

In the ripening of cheese various chemical changes occur, which make the cheese more readily digested than when it is fresh. Both the curd and the fat undergo changes of a fermentive kind. By the same process the peculiar flavour of the cheese is developed. In the process of ripening a mould appears, common vegetable fungoid growths developed from spores that have gained entrance to the cheese in course of manufacture. These vegetable moulds grow at the expense of the substance of the cheese, and therefore diminish its absolute nutritive value. On the other hand, they add to its flavour and its digestion, probably to some extent mechanically by the fine veinlets of mould permitting the cheese more readily to crumble down and be attacked in smaller particles by the digestive fluids. The cheese-mite, or *Acarus domesticus*, is produced from the eggs of the insect sown in the curd. Cheese-maggots are the larval stage of a fly, the cheese-fly—*Piophila casei*. These may be destroyed by strong heat or immersing the cheese in whisky.

It will be noticed from the tables of composition that cheese is rich in nitrogenous ingredient and fat, whole-milk cheese containing these to the extent of over two-thirds. While this is so, there is a difficulty in making use of these nourishing ingredients from the solidity of the mass, and thus cheese is used rather as a mere adjunct to food than for its nutritive value. Cream-cheeses are usually more easily digested, because the large proportion of fat makes them crumbly and more easily broken down. When cheese, however, is mixed with other food-stuffs, as with corn-flower, bread, &c., when grated to form cheese-pudding, these ingredients separate up the cheese particles; and then a quantity may easily be taken—sufficient to be of considerable nutritive value. Such additions also make up what is deficient, indeed practically wanting in cheese, the starchy or sugary element. It may further be noticed that the saline constituents of cheese are rich in phosphates, of value in bone formation. In a sample of double Gloucester of a total of 4·9 per cent salines, phosphates contributed 3·1.

Various Animal Foods Compared.

It will now be of interest and value to compare the relative richness in nutriment of the various animal foods we have considered. For that purpose I shall place alongside of one another the composition of the chief kinds of such food from the tables already given:—

	Lean Beef.	Bacon.	Fowl.	Egg.*	Cod.	Milk.	Cheese (Cheddar).
Water	72	13·9	73·15	71·7	77·5	86·87	27·83
Nitrogenous	19·3	9·0	22·65	14·0	18·5	4·65	44·47
Fat	3·6	74·1	3·11	11·0	3·0	3·50	24·04
Sugar	—	—	—	—	—	4·28	—
Saline.........	5·1	3·0	1·09	1·3	1·0	0·70	3·66

* 2 per cent of extractives and membranes omitted.

If we exclude water and salines then from the above tables, we find that 100 parts of each food-stuff contain of nourishing materials the following amounts:—

Beef, ...	22·9	Cod, ...	21·5
Bacon, ...	83·1	Milk, ...	12·43
Fowl, ...	25·76	Cheese, ...	68·51
Egg, ...	25·0		

This shows that beef, bacon, fowl, egg, and cod come very near to one another in the proportion of nourishing material they contain. Cheese stands high in the list, but it is really in a different class from the others, because it cannot be eaten in any quantity, and is really a food adjunct, and cannot take the place of a chief article of diet. Allowing, then, for variations in composition, we may say that, weight for weight, beef, bacon, fowl, egg, and cod are comparatively nearly of equal nutritive value, considering the total nutriment each contains. Considering the details of the composition, we see how alike beef, fowl, and cod are, and how one could readily take the place of the other in a diet, without any deficiency in a particular ingredient arising from the change. It is specially interesting to note how completely fish may

take the place of beef; and, when we remember the marked difference in price between the two, this is a point worthy of being brought markedly into prominence. It is an irresistible plea for the more extended use of fish in the diet of the people. Bacon heads the list; but the small proportion of nitrogenous material and the excess of fat exclude it from entering into serious competition with the other three, though it is nevertheless a highly valuable food-stuff. It is evident also that egg occupies a similar platform to beef, fowl, and fish, and at any rate does not possess any marked pre-eminence. It has no right to be considered, as it so commonly is, a concentrated food-stuff.

II. Non-Nitrogenous Animal Foods.

BUTTER AND BUTTER SUBSTITUTES, LARD AND DRIPPING.

Percentage Composition of Butter and Oleo-margarin.

	Butter.	Oleo-Margarin.
Water	9·40	10·50
Nitrogenous (Curd).	1·40	—
Fat	86·50	87·00
Milk-sugar	·80	0·70
Saline	1·90	1·8

Butter, though consisting mainly of milk-fat, contains a small proportion of the other ingredients of milk. Butter may be made directly from the sweet milk, but usually is made from cream. Rather more butter is obtained from the whole milk, but the process is more laborious, because of the large bulk of fluid. It takes about 23 pints of milk to yield 1 lb. of butter. A good cow will yield 8 to 12 lb. of butter a week during the season; and well-selected cows will yield on an average 2 to 2½ cwt. of butter per year. The milk is placed in shallow pans and kept at a temperature of about 60° F., at which temperature the cream rises best. Once or twice in twenty-four hours the cream is removed, and placed in a crock till sufficient has been collected. Sometimes annatto is added to it to give a colour, or grated carrots are steeped in it and strained out next morning for a like purpose. In large establishments for the manufacture of butter, the cream is now separated by centrifugal machines. Owing to the keeping the cream becomes slightly sour, because of the change of some of the milk-sugar into lactic acid. This facilitates the separation of the butter, though butter made from sweet cream has a pleasanter taste, and is said to keep much longer. The cream is then placed in a churn, of which there are many forms. Whatever their form, the purpose is the same, namely, by mechanical agitation of the milk globules to break the fine film of albumin which surrounds them, and thus to permit the escape of the oil. The fat thus released runs together, and lumps of butter are produced. The cream is put into the churn at a temperature of about 60° F., at which it is kept. The churning process occupies from thirty to forty-five minutes. The butter is then collected, washed in cold spring-water, to rid it as much as possible of the other elements of milk, and is then kneaded to express the water. It is thereafter mixed with salt as a preservative. In fresh butter there is always added salt to the extent of ½ to 2 per cent. Salt butter contains from 3 to 6 pounds of salt to every 112 pounds of butter, and if it is to be kept for an unusually long time a little sugar is added, not exceeding 8 ounces to every 112 pounds. During the whole process great care requires to be taken to ensure the cleanness of the vessels, churns, &c. used, and of the atmosphere in which the butter is kept. For butter very readily acquires a change of flavour from odorous or smelling substances in its neighbourhood, as well as from any highly-flavoured food eaten by the cow. While the above table gives a fair average composition, very varying results are obtained from different samples. The quantity of curd, milk-sugar, and water will depend upon the care and thoroughness with which the butter has been washed and pressed. An increase in the quantity of curd present diminishes the keeping quality of the butter, from the tendency of the curd to undergo decomposition. The milk-sugar and curd are present in too small quantity to impart any nutritive quality of any consequence apart from the fat.

There is a simple method of making a rough estimate of the quantity of the three chief constituents, which will aid in determining the quality of any particular sample of butter. Place some butter in a test-tube, and melt it by immersing the tube in warm water. As soon as the butter becomes liquid, it will separate into its chief constituents, a layer of water at the bottom, a layer of oil on the top, and between the two a ring of curd. The water should form little more than an eighth of the total liquid in the tube, the oil should form the remainder, the ring of curd being of no marked extent. Any adulteration with water would be quickly detected by such a simple method as this, and any excess of salt would also be noticed. Butter fat is a very complex substance. It is a mixture of various fats, the chief being olein,

stearin and palmitin, and butyrin; while, in small quantity, there also exist other fats, called caproin, caprylin, and rutin. Each of these fats is a chemical compound of a fatty acid and glycerin. Thus oleic, stearic and palmitic, and butyric acids are the acids which, in combination with glycerin, yield the fats olein, &c. The oleic, stearic, and palmitic acids do not dissolve in water, but the others do dissolve. Now sometimes a bad flavour is formed in butter by the decomposition of the butyrin and caproin into their respective fatty acids. These being soluble, the bad flavour may be removed by washing the butter.

In 100 parts of butter-fat the proportion of the several fats is as follows:—

Olein	42·21
Stearin, Palmitin	50·00
Butyrin	7·69
Caproin, Caprylin, Rutin	0·10

Although the last four fats exist in comparatively small quantity, it is they which give to butter its peculiar flavour, distinguishing it at once from other animal and vegetable fats, and it is on the quantity of these last four that analysts mainly depend for distinguishing between pure butter and manufactured substitutes, as will be seen from the analysis given below of the fat of oleo-margarin.

Oleo-margarin, margarin, or **butterine** are various names given to articles manufactured from various animal fats as substitutes for butter. The process is briefly as follows:—Beef fat is principally used. It consists chiefly of stearin, margarin, and olein. It is melted by means of hot water, when the animal fat separates as a yellow oil, water and solid particles sinking to the bottom. A scum of impurities forms on the surface, which is removed, and the oil is run into troughs, where it is kept till much of the stearin crystallizes out. The oleo-margarin is afterwards removed and filtered through cotton, the separated stearin being afterwards used for the manufacture of candles. The oleo-margarin is put into a press and then churned with milk, it being itself quite tasteless, to give it the flavour of butter. It is next coloured, and, after rolling with ice, is packed for use.

As will be seen from the table the composition of oleo-margarin does not differ materially from that of butter. It is indeed a matter of difficulty for experts to distinguish well-made oleo-margarin or butterine from pure butter. Chemists agree in declaring wholesome butter substitutes to be as valuable a food-stuff as pure butter, and to be really not one whit inferior. Its cheapness brings it within the reach of many who find it difficult to purchase the real article. The prejudice against its use is not justified. It is, unfortunately, too often the case that butterine is sold as real butter, and at, or nearly at, the price of the native product. If the people would put prejudice aside, and instead of buying inferior kinds of butter, be not ashamed to buy good quality of butterine or oleo-margarin, they would get an article not easily distinguished from the best butter, at a much more moderate cost. Legislation, instead of hampering the manufacture and sale of these butter substitutes, is now endeavouring to secure that butter substitutes shall not be sold under the name and at the higher price of butter. Chemists distinguish between pure butter and butter substitutes by the proportions of the various fats in each. The fat of oleo-margarin contains:

Olein	30·4
Stearin	46·9
Palmitin	22·3
Butyrin, Caproin, Caprylin	0·4

The marked deficiency in the last three fats as compared with their amount in true butter is evident by comparison with the table of composition of butter-fat given above.

Lard is the fat of the pig melted out from the tissue of which it formed a part. This is done by cutting up the fatty tissue into small pieces and placing them in vessels, usually made of iron, heated by steam. As the fat melts, any water and debris fall to the bottom, and other impurities rise to the surface. The pure lard is run off into bladders or kegs. Pure lard should have no smell and almost no taste, and should be quite free from colour. It usually contains nearly 10 per cent of water, though by various methods it may be made to take up a much greater quantity than this. Smith states that lard should contain 8,237 grains of carbon per pound, the hydrogen it contains being reckoned as carbon (see p. 532).

Dripping is fat obtained in the process of roasting flesh. It is almost a pure fat, and differs from lard mainly in the flavour it has derived from the meat. Both lard and dripping are highly valuable as energy-yielding food-stuffs.

THE COMPOSITION OF VEGETABLE FOODS.

I. Nitrogenous Vegetable Foods.

THE CEREALS OR GRAINS.

Average Percentage Composition of Grains.

	Wheat.	Oats.	Rye.	Barley.	Indian Corn or Maize.	Rice.	Millet.	Buckwheat.	Dhurra, Indian Millet.
Water	13·56	12·92	15·25	13·78	13·88	14·41	11·26	13·4	12·2
Nitrogenous	12·42	11·73	11·43	11·16	10·05	6·94	11·29	15·2	8·2
Fat	1·70	6·04	1·71	2·12	4·76	0·51	3·56	3·4	4·2
Starch, Sugar, &c.	67·89	55·43	67·83	65·51	66·78	77·61	67·33	63·6	70·6
Fibre	2·66	10·83	2·01	4·80	2·84	0·08	4·25	2·1	3·1
Saline	1·77	3·05	1·77	2·63	1·69	0·45	2·31	2·3	1·7

With one exception all the substances mentioned in the above table belong to the natural order of the grasses (*Graminaceæ*). The term "cereals" is employed to include them, meaning the fruit of such grasses as are used for food. Buckwheat is not a grass, but belongs to the same natural order as rhubarb and dock (*Polygonaceæ*). It is used pretty much as are the grains, and, therefore, we may consider it here.

The nutritive value of all these substances is clearly evident from the above table. The analyses of the first seven are from a German source (Kœnig), and represent the average of several hundred analyses; the last two are from an English source (Church).

If we leave out the water, the fibre, which is non-digestible, and the saline constituents, then we find that some of these seeds contain as much as 85 parts (rice) of nourishing material in the 100, while only barley and oats fall below 80 per cent. In regard to oats, I do not think the table above does it justice. Its total nutritive material is represented as falling as low as 73 per cent. Nowhere are oats used so largely or grown to such perfection as in Scotland, and the above table is not a fair representative of good Scotch oats. But I preferred to give the analyses as nearly as possible all from the same authority, to make comparisons more fair, and therefore have not substituted another analysis in this case in place of Kœnig's. An analysis of six samples by Fehling gave from 80·93 to 82 per cent of nutritive material. Without doubt the finest qualities of oats contain an excess of nutritive material over that of the finest English wheat.

When the details of the composition are examined some very interesting facts are brought out. They all contain both the tissue-repairing and the energy-yielding kinds of food-stuffs. In all of them the energy-yielding food-stuffs, starch, sugar, and fat specially abound, though the tissue-repairing material (nitrogenous) is in very good proportion. According to the above table the following is the order of richness in nitrogenous or proteid substances:—

Buckwheat.
Wheat.
Oats.
Rye.
Millet.
Barley.
Maize.
Dhurra.
Rice.

The following is the order of richness in fat:—

Oats.
Maize.
Dhurra.
Millet.
Buckwheat.
Barley.
Rye.
Wheat.
Rice.

The following is the order of richness in carbohydrates (starch, sugar, &c.):—

Rice.
Dhurra.
Wheat.
Rye.
Millet.
Maize.
Barley.
Buckwheat.
Oats.

If we take all three nutritive materials, then, of the ordinary grains used as food oats and wheat rank highest, and, considering the finest qualities, oats have the pre-eminence.

Wheat is an annual grass, of which there are several species. That commonly grown in England is *Triticum vulgare*, of which there are two varieties—summer and winter wheat (*Triticum æstivum* and *T. hybernum*). It is culti-

vated in nearly all temperate climates, but more in the northern than southern hemispheres. It varies much with the soil on which it is reared, and with the dryness or wetness of the season. There is the hard wheat, such as is grown in Odessa, Africa, and Egypt. It is horny and semi-transparent in appearance, is specially rich in nitrogenous or proteid material, and less rich in starch than the average shown in the above table. It is from such kinds that macaroni and vermicelli are prepared. The soft or white wheat is more tender and floury, is more easily ground, contains more starch and less nitrogenous material, and makes a finer flour. There is an intermediate variety grown in France.

Wheat, as supplied to the miller, is deprived of its husk. The seed consists of an outer portion, formed of a series of coverings or membranes, and of an inner part, the substance of the seed itself, divided off into compartments in which are starch grains. The figure (Fig. 194) shows these different parts when a thin slice, taken across a grain of wheat, is examined under a highly magnifying microscope. The various coverings are removed in the process of grinding and dressing for flour and form the bran, while it is from the starchy centre that the fine flour is made. The branny coatings are specially rich in nitrogenous material, though the starchy centre is not by any means devoid of it, the compartments in which the starch grains lie being formed of albuminoid material. It appears that the innermost layer of the seed covering (3 of Fig. 194) is richest in albuminoid material. In this coat there is also present, it appears, a ferment (cerealin) capable, under proper conditions of heat and moisture, of converting the starch of the grain into sugar.

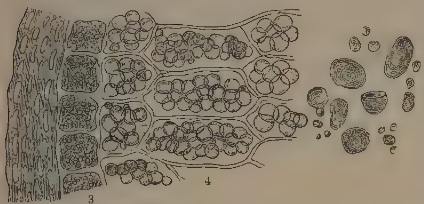


Fig. 194.—Section of Wheat Grain—highly magnified. To the right the granules of wheat starch are shown more highly magnified.

1 indicates the outermost seed-coat, formed of several rows of thick-walled cells, 2 is an inner fine seed-coat, and 3 are called the gluten cells where the cerealin is found. All these yield the bran. 4 points to the compartments filled with starch grains.

Whole wheat is hardly at all used for food; but it once made a popular dish in England, called **frumity or furmenty**, which is still occasionally seen in Yorkshire. It was a common dish in harvest-home celebrations. In its preparation new wheat was steeped in water in a pan, placed in the oven and kept at a temperature of about 120° Fahr. for some eighteen to thirty-six hours. Not only did the grain swell in the process, but by the heat and moisture the ferment was enabled to act upon the softened and ruptured starch grains, converting them into sugar. The grain was then boiled with milk; and sweetening and spice were added. It is said to be a delicious dish, but the presence of the husk and bran made it indigestible.

By the grinding of wheat various products are obtained. The whole grain may be ground as finely as possible, no part being removed. Modern methods of milling now make it possible for very much finer whole meal to be placed in the market than formerly. Some of the objections to whole meal have thus been removed. The branny portions are not easily reduced to a fine condition, and if they are present in the meal in particles of any size, not only are they indigestible, but their roughness and their sharp edges irritate the bowels, and so stimulate them as to cause the food to be hurried along the bowel before the nutritive material can be extracted from it. Indigestible themselves, they thus also prevent the due digestion of other food. The grinding of wheat has now, however, become a very elaborate process, and in mills, constructed and furnished in the most approved fashion, a very large variety of products is obtained from the wheat. The wheat is passed between rollers, in which it is submitted to a cracking and squeezing action, the purpose of which is to enable the kernel to be separated from the other coverings. It is passed through a series of rollers, five, six, or seven, being submitted between each "break" to a series of sifting and winnowing and dressing operations, by which branny particles are separated out, and the flour which the "break" has produced is sifted out, the intermediate portion being passed on to the next roller, and so on. Thus, after it has passed through two or three rollers, branny portions have been largely removed, and the product is white and granular, consisting chiefly of the kernel of the grain broken up into coarser or finer particles, according to the exact number of rollers through which it has passed. To this product of the wheat, in its conditions of coarse or fine particles, the name **semolina** is given. By further operations of rolling, dressing, &c., it may be reduced to the form of flour. Various terms are applied to the differ-

ent products obtained in the various stages of the milling process. A simple division of the products is into flour, middlings, and bran. Of the bran, even, there are many degrees of fineness. Thin bran is that part of the covering which is often separated before the grain is broken according to one method, that of Mège Mouriés, by damping and rubbing the grain. Then there is long bran, the next outermost coat of the grain. Pollard is a finer bran. Middlings consist of fragments of the kernel of the grain mixed with branny particles, and as they are submitted to further rolling they become reduced and separated by winnowing, &c., from the branny portions. Tailings is a term applied to lighter portions of the wheat, separated out by winnowing, consisting of parts of the kernel adhering to the bran, which, by subsequent breaking, become separated, so that finally the tailings become reduced to simple bran. Sharps is the product a stage behind the fine flour, in which the starchy part of the grain is yet in particles, and in which some of the outer parts of the seed are still present, though in a fine state of division. Fine sharps is also called seconds flour, and coarse sharps thirds. It is worth noticing those different varieties, because their chemical composition is different. The chief difference consists in the varying proportion of nitrogenous material which each contains. As already noted, the outer parts of the grain are richest in nitrogenous or albuminoid material, and the kernel is richest in starch. Accordingly, as the coarser portions are removed, and the stage of fine white flour is reached, the proportion of albuminous material falls, and that of starch rises, so that the finest white flour, consisting essentially of the heart of the grain, is poorer in tissue forming and repairing material than the inferior qualities of flour, in which a larger proportion of the outer parts of the wheat is present. This is well shown in the following note, taken from Church, of the relative proportion of the nitrogenous material in one pound of some of the products named:—

			oz.	grs.
1 pound of finest flour	contains of nitrogenous	material,	1	297
,, middlings	,,	,,	2	105
,, coarse sharps	,,	,,	2	246
,, fine pollard	,,	,,	2	210
,, long bran	,,	,,	2	182

In the outer parts of the grain, also, the saline constituents reside in greatest abundance. Thus they amount in fine flour to 50 grains in the pound, in middlings to 147 grains, in fine pollard to 399 grains, and in long bran to 1 ounce 60 grains. Much of the saline material consists of phosphates, of great value in the formation of bone. Thus a seconds flour is superior to the finest quality from a nutritive point of view, because of the larger proportion of material useful for the repair of all the tissues and the formation of bone. It might also be said, at least so far as the chemical composition is concerned, that a still lower quality of flour possessed a higher nutritive value. But when one takes coarser kinds, the element of digestibility enters into the question. It has been shown, by direct experiment, that when bread made from the finest flour was consumed, less was expelled from the alimentary canal in the form of waste than when bread of coarser qualities was eaten. It is not possible, therefore, to make the chemical constitution the only test of the nutritive quality of the flour. The following table shows the differences that have been indicated:—

	Fine Flour.	Whole Meal.	Bran.
Water	13·0	14·0	14·0
Nitrogenous	10·5	21·8[1]	15·0
Fat	0·8	1·2	4·0
Starch, Sugar, &c.	74·3	59·7	44·0
Fibre	0·7	1·7	17·0
Ash	0·7	1·6	6·0

[1] Of which a large portion is not useful for nutrition.

Flour consists, it appears from the table, to the extent of three-fourths of starch, and contains only a tenth of nitrogenous material, with less than a hundredth part of fat. The starch may be separated from the nitrogenous material by a comparatively simple process. The flour, made into a stiff dough with water only, is placed on a sieve or on a piece of muslin tied over the mouth of a wide bowl, and worked with the hand while a stream of water flows upon it. The starch granules pass through the muslin or sieve with the water, and the process is continued till all the granules have been washed away, and the water passes through quite clear. The starch may be recovered from the bowl by decanting the water, as it does not dissolve in cold water, and then drying it. There remains on the muslin a yellowish, semi-transparent, adhesive substance, somewhat elastic, to which the name **gluten** is given. When dried it is a horny, brittle substance. This may be made without further preparation into small rolls or buns and baked in the oven, when one has **gluten bread**. It swells greatly during

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